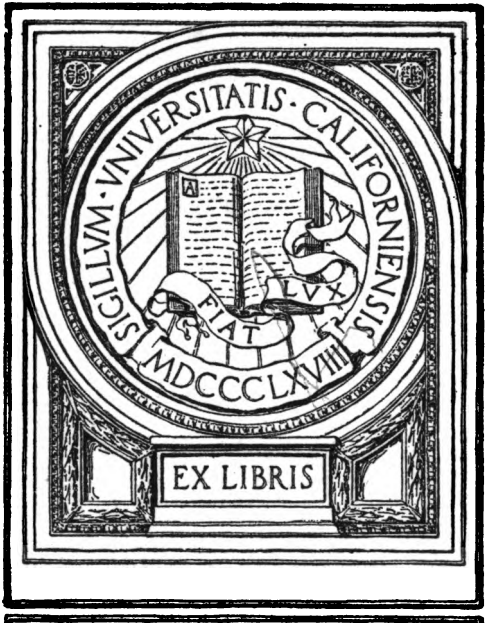


PRACTICAL

Automobile Hand Book

FOR

Owners, Operators and Mechanicians

BY

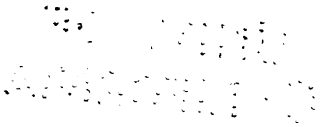
CHARLES V. MILWARD

Mechanical Engineer

PRICE, $1.00

HATHAWAY & BROS., Publishers

PHILADELPHIA



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With over Four Hundred Questions and Answers
Fully Illustrated with Sharp, Clear Line Drawings

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For the Owner, Operator, Mechanician and others who are interested in the care and operation of Gasoline and Electric Automobiles. A simple and non-technical treatise, giving full detailed instructions on repairing, operating, caring for, adjusting, high and low tension, ignition, wiring, timing, valve-setting, magneto, carburetor, the secondary distributer, storage battery, transmission, differential, tires, engine troubles, two-cycle and four-cycle motors, the Knight sliding sleeve valve motor, why the motor stops, the electric vehicle, practical information, etc., etc. With up-to-date and most approved answers to all questions liable to be asked by a board of examiners for the purpose of examining the applicant for a chauffeur's license.

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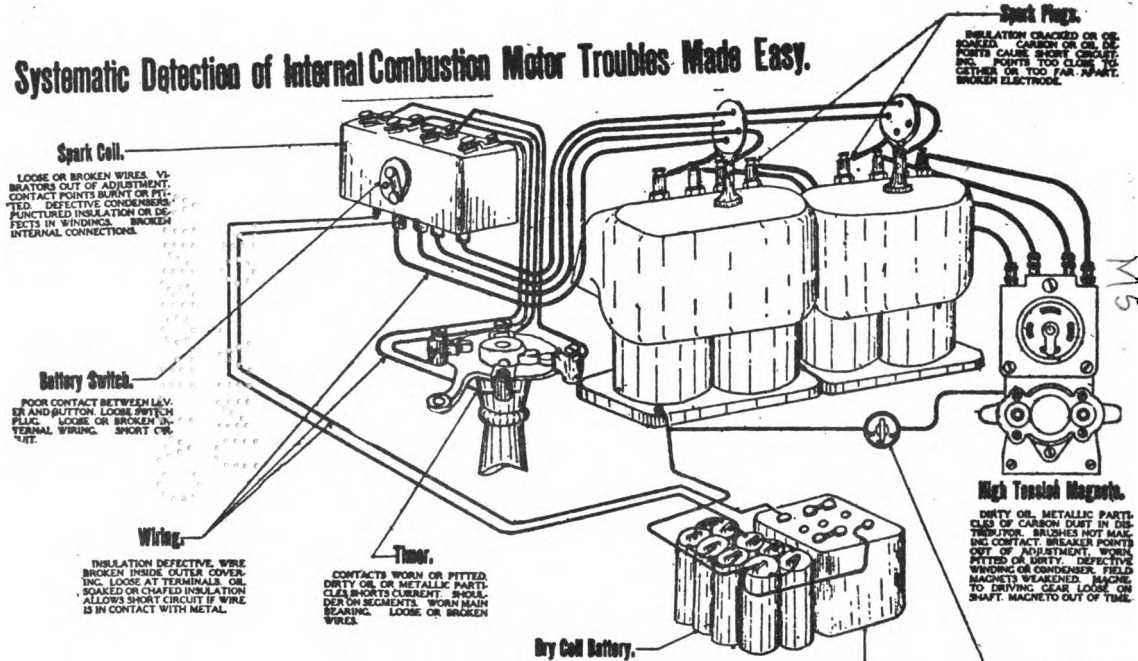
Systematic Detection of Internal Combustion Motor Troubles Made Easy.



DEFECTS IN IGNITION APPLIANCES WHICH CAUSE TROUBLE.

FOREWORD

In preparing the PRACTICAL AUTOMOBILE HANDBOOK it has been the endeavor to produce a book that would meet the requirements of the owner, chauffeur and mechanician, and be easily understood by the average reader. The writer, being the author of the "Chauffeur's Blue Book," which proved to be such a success, that he has combined the writings of that book with this one, thereby making it the most thorough and practical work of its kind ever published. The text matter has been prepared from the amateur's standpoint, making it a most simple and practical treatise. All technical words and difficult mechanical problems have been avoided. Much thought and care have been exercised in the preparation of this work. Some of the best authorities on automobiles in the country have been consulted. The author wishes to particularly acknowledge the courtesy of *Motor Car* for the reproduction of the drawings and descriptive matter furnished by them. There is a big difference in books, just as in other things. There are several descriptive books on automobiles at present on the market, but, while their information is of great value, the text is usually treated too technically to be of interest to the aver-

age reader. With this point in mind, and also with a view to explaining the mechanism of an automobile and its troubles intelligently and interestingly, the writer has prepared the PRACTICAL AUTOMOBILE HANDBOOK, setting forth the various points in detail. The questions and answers contained in this book are in no sense theoretical or imaginary. Every one of them is practical, and every point is clearly indicated, and the operator is wonderfully helped in successfully passing any examination, should he be called upon so to do.

QUESTIONS AND ANSWERS

Q. What is the motive power of an automobile?

A. The motive power of an automobile is a gasoline engine, which power comes from the explosion of compressed gas in the cylinders of the engine, which transmits the power derived from the explosion to the piston through the connecting rod to the crank shaft, then to the rear or driving wheels.

Q. In a four-cylinder engine do all the cylinders explode at one time?

A. No; the cylinders are alike and explode one at a time in rapid succession.

Q. What causes this explosion?

A. The explosion is caused by the compressed gas being ignited by an electric spark made in the combustion chamber of the cylinder.

Q. What causes this electric spark?

A. The electric spark is created either by a magneto or a battery attached to a spark coil.

Q. How is the electric spark carried to the cylinders?

A. By wires with one end attached to the magneto, or spark coil, and the other end attached to a spark plug which is screwed in the head of the cylinder.

Q. Of what use is a carburetor?

A. It is a device for transforming gasoline into a vapor, by passing air either through or over a body of gasoline, and carrying off a part of the gas-

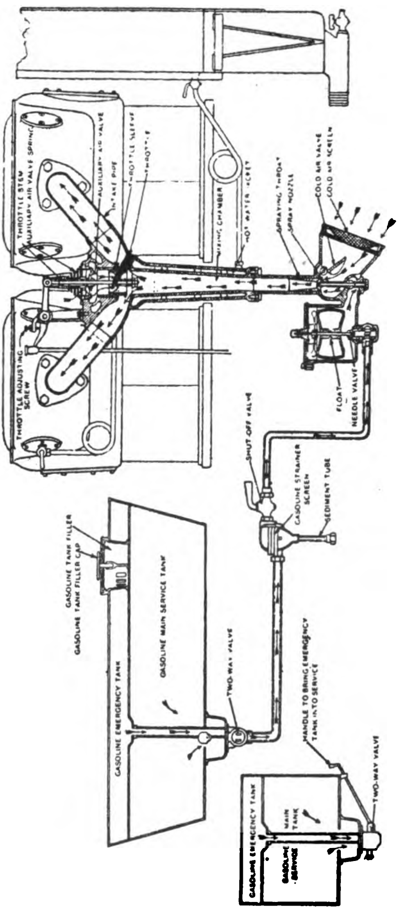


FIG. 15. Peerless Gasoline System

oline in the form of vapor with the air. See Figs. 15 and 16.

Q. Where do the burnt gases go after each explosion?

A. They pass out the exhaust valve through the exhaust pipe, into the muffler to the atmosphere.

Q. Of what use is the throttle lever?

A. To control the supply of gas taken into the cylinders. See Fig. 16.

Q. Of what use is the spark lever?

A. It controls the time of explosion to give a late or early explosion, as may be desired. See Fig. 16.

Q. Are gasoline engines single or double acting?

A. Single acting, using one end of the piston only. See Fig. 12.

Q. What are the cycles of operation in a four-cycle engine?

A. (1) Intake. (2) Compression. (3) Explosion. (4) Exhaust.

Q. Describe the cycle of operation in a four-cycle gasoline engine.

A. The first or downward stroke of the piston, a charge of gasoline vapor and air, is drawn into the cylinders, through the intake valve; when the piston is on its upward stroke the intake valve is closed, which prevents the gas from escaping. Therefore, the cylinder being air-tight, and as the piston rises to the top of the cylinder it compresses the gas, and just before the piston starts on its downward stroke an electric spark takes place within the cylinder, igniting the charge, causing an explosion, which drives the piston down on its working stroke. When the piston starts on its upward stroke the exhaust valve opens, allowing the burnt gases to pass out. When the piston reaches the top of its exhaust stroke the

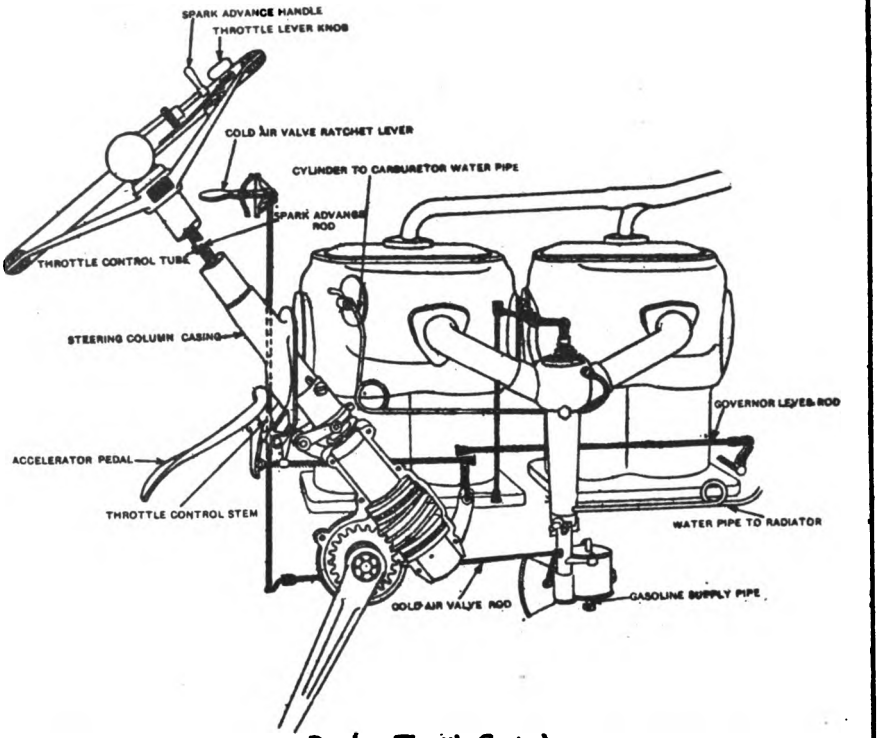


FIG. 18 **Peerless Throttle Control**

exhaust valve closes and the intake valve opens. The cylinder is now ready for a fresh charge of gas, which is drawn in on the next downward stroke of the piston, and the same series of operations are repeated.

Q. Of what use is a flywheel on an engine?

A. Its use is to make the speed of the revolution more even, allowing the crankshaft to turn more steadily, while the unevenness of motion comes on the piston; its use is also to overcome the dead center point.

Q. What is a spark plug? What does it consist of? Of what use is it on a gasoline engine?

A. The spark plug is a device used on gasoline engines to ignite the charge after it has been compressed in the cylinders. The spark plug consists of two terminal electrodes which are separated from each other at the lower extremity by an air gap, and at the other portions by means of suitable insulating material. The gap between the points should not be over 1/32 of an inch, so that the resistance of the gap will not be so high that the current cannot jump between them when the gases are compressed. See Fig. 18.

Q. Define the word cycle as applied to gasoline engines.

A. It is the four stages the conditions of the cylinder must pass through to develop one power stroke.

Q. What two types of combustion motors are mostly used?

A. The two-cycle and four-cycle.

Q. Name two methods in general use for transmitting the power of the engine to the driving wheels.

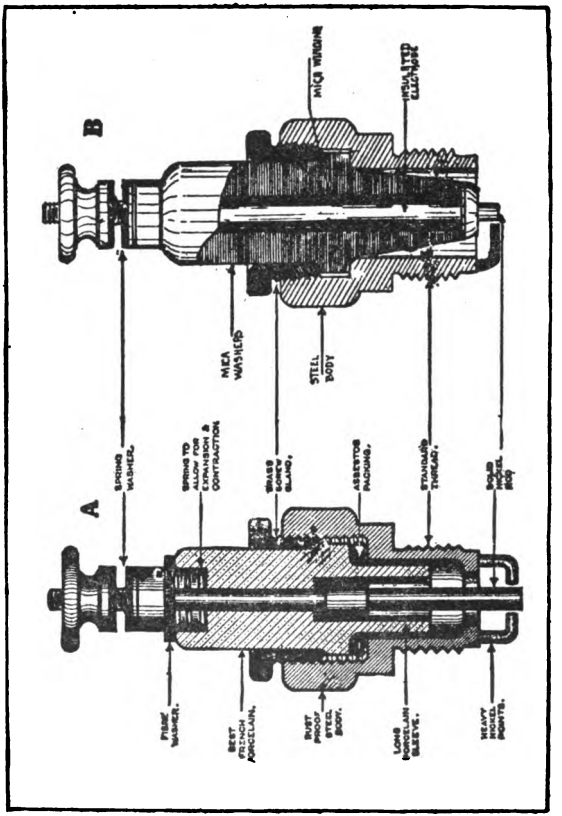


FIG. 18—EXAMPLES OF WELL DESIGNED SPARK PLUGS

Type A Has Porcelain for insulation, While the Electrode of Type B Is Protected by Mica, Sheet and Washer.

A. The chain drive and the shaft drive.

Q. What advantages have the muti-cylinder engines?

A. Minimum vibration, flexibility of operation, they develop more power.

Q. What type engine combines these advantages?

A. The six-cylinder type.

Q. Name three types of clutches that are used ordinarily on automobiles.

A. The Disc, Band and Cone.

Q. What is one of the main requirements of the combustion chamber?

A. It should be kept free from carbon and soot.

Q. What is the exploding chamber of a gasoline engine?

A. It is that part of the cylinder where the gases are compressed and exploded.

Q. Of what use is the clutch?

A. Its use is to start the car without the necessity of stopping the engine.

Q. How many strokes has a four-cycle motor?

A. Four strokes.

Q. What is the duty performed by each stroke?

A. First revolution: First stroke—
Downward movement of the piston; suction charge.
Second stroke—
Upward movement of the piston; compression of charge.
Second revolution: Third stroke—
Downward movement of the piston; explosion of gases.
Fourth stroke—
Upward movement of the piston; exhausting burnt gases.

Q. At what point in the cycle should the electric spark take place?

A. The electric spark should take place just as the piston starts downward on the explosion or working stroke.

Q. How many explosions in a six-cylinder motor per revolution?

A. Three.

Q. How many valves has a six-cylinder motor?

A. Twelve; six are intake and six are exhaust.

Q. Does the explosive mixture enter the cylinders in liquid form?

A. No; it enters the cylinders in the form of gas.

Q. By what means is the gasoline transformed into a gaseous vapor?

A. It is done by the action of the carburetor.

Q. How does the gas get into the cylinder?

A. It is drawn into the cylinder by the vacuum created by the piston on the downward or suction stroke.

Q. Does the movement of the piston produce suction?

A. Yes.

Q. In what stroke and what direction does the piston travel to produce suction?

A. The intake stroke, while the piston is going downward.

Q. With motor running, what may the muffler cut-out indicate when held open?

A. It is an easy way to indicate whether the motor is running on all cylinders.

Q. Of what use is the muffler cut-out?

A. When the cut-out is held open it gives the engine more power.

Q. How does the muffler cut-out, if held open, increase the power of the engine?

A. By its use the exhaust is given a free outlet without having to pass through the muffler, reducing all chances of any back pressure.

Q. What is a water jacket?

A. It is the part of the cylinder which allows water to run through for cooling purposes.

Q. What does advancing the spark do?

A. It causes the spark to take place before the piston has completed its compression stroke.

Q. How many throttle levers are there on a car?

A. Generally one, although some cars have two, a hand throttle and a foot throttle. The foot throttle is known as the accelerator.

Q. Of what use is the accelerator?

A. By its use an instant increase of speed can be accomplished by pressing the accelerator pedal with the foot. This opens the throttle instantly without touching the gas-controlling lever, but, immediately upon releasing the accelerator pedal, the car settles back to the speed at which the lever is set.

Q. After starting the motor, what is the proper position for the spark and throttle levers?

A. The spark lever should be advanced about half way, while the throttle should be opened just enough to keep the motor running.

Q. The highest and lowest point of the piston action is called what?

A. The center, or end of stroke.

Q. What is the space between the top center of the piston and the top of the cylinder called?

A. The explosion chamber.

Q. The distance the piston travels from center to center is called what?

A. The length of stroke.

Q. In what position should the gear lever be in starting the engine?

A. It should be in a neutral position.

Q. If you cannot use the starting crank, how can you start the engine?

A. Place the high-speed gear in and let the clutch in and then have the car pushed forward until the engine is turned over and started.

Q. How would you determine the order of firing in the cylinders?

A. By disconnecting the wires from the spark plugs and turning the engine over by hand, with the switch on, then watch each wire as it sparks.

Q. In a single-cylinder motor, running at 1200 revolutions per minute, how many contacts per minute will occur in the timer?

A. Six hundred per minute.

Q. In a four-cylinder motor how many would occur?

A. Twenty-four hundred per minute.

Q. In a six-cylinder motor how many?

A. Thirty-six hundred per minute.

Q. What is a sprag?

A. It is a steel bar with one end connected to a part of the frame, and the rear end hangs suspended by a chain or strong wire, by which it may be dropped to the ground to prevent the car from running down hill backward.

Q. When does a motor develop more power, when it is warm or when it is cold?

A. When it is warm.

Q. Why is the power of the motor reduced when it is cold?

A. Because the expansive force of the gases is reduced.

Q. May kerosene be used as a fuel for combustion motors?

A. Yes, to some extent.

Q. What is the function of the driving shaft?

A. It transmits the power to the rear wheels.

Q. What is the connecting rod attached to?

A. One end is attached to the piston; the other end to the crankshaft.

Q. What is the function of the connecting rod?

A. It transmits the power from the piston to the crankshaft.

Q. What part of the motor is the force of the explosion directed on?

A. The piston.

Q. What direction does the piston travel when the explosion takes place?

A. Downward.

Q. What is this stroke called?

A. The explosion or working stroke.

Q. What is the next stroke called after the piston completes the explosion stroke?

A. The exhaust stroke.

Q. What is a horsepower?

A. It is the force required to raise 33,000 pounds one foot high in one minute, although it is much greater than most horses have the strength to perform.

Q. What is meant by piston speed of 1000 feet per minute?

A. It means that if a motor has a 6-inch stroke, the piston travels one foot every revolution, and the crankshaft would have to rotate 1000 revolutions per minute, which would give you a piston speed of 1000

feet per minute, or if the motor has a 12-inch stroke, the piston would travel two feet every revolution of the crankshaft, the motor would have a piston speed of 1000 feet per minute, at 500 revolutions per minute.

Q. What is the most familiar formula used for estimating the horsepower of an automobile motor?

A. The A. L. A. M. formula.

Q. What is the formula?

A. The formula is as follows: H. P. $= \frac{D^2N}{2.5}$

D is the diameter of the cylinder, N is the number of cylinders, and 2.5 is a constant.

Q. If a gasoline engine refuses to start, state the probable causes.

A. (1) No gasoline; tank empty or supply pipe shut off. (2) Switch plug not in position. (3) Fouled spark plugs. (4) Improper mixture. (5) Improper ignition. (6) Valves may be stuck. (7) Poor compression. (8) Water-jacket leak, letting water in the cylinder. (9) Spark coil not adjusted properly. (10) Spark plugs broken.

Q. What causes an engine to miss fire?

A. (1) Insulation wires broken. (2) Carburetor not adjusted properly. (3) A loose wire. (4) Contact on timer may need cleaning. (5) Spark coil may need adjusting. (6) Gasoline feed pipe may be choked. (7) Water in the gasoline. (8) Fouled or broken spark plug. (9) Spark plugs or valves may be loose.

Q. What is the cause of a hissing sound on a gasoline engine?

A. Exhaust pipe may be loose or cracked, relief tap open, spark plug loose or broken.

Q. What is the cause of an engine firing regularly, but very weak?

A. (1) Carburetor not adjusted properly. (2) Vibrator on coil may need adjusting or cleaning. (3) Inlet valve springs too weak. (4) Muffler may be choked with carbon. (5) Poor compression valves may leak. (6) Poor lubrication.

Q. If the engine runs regularly and car seems to drag, what is the cause?

A. (1) Brakes may not be released. (2) Clutch may be slipping. (3) Springs on clutch may be weak. (4) Insufficient lubrication. (5) Cones on the wheels may be tight. (6) Oil on clutch surface.

Q. What would cause an engine to stop suddenly?

A. (1) Gasoline tank empty or air-bound. (2) Gasoline supply pipe choked. (3) Spark plug broken. (4) Electric circuit disconnected. (5) Loose or broken wires.

Q. What causes an engine to knock?

A. (1) Spark may be too far advanced. (2) Mixture may be too rich. (3) Pre-ignition, due to overheated engine. (4) Bearings may be loose. (5) Cylinder on crank case may be loose. (6) Flywheel may be loose on shaft.

Q. What causes an engine to get overheated?

A. (1) Using low gear too much. (2) Driving with spark too far retarded. (3) Muffler choked. (4) Water pump not working. (5) Radiator tubes or water jacket stopped up. (6) Not enough water in radiator. (7) Fan not working properly.

Q. What causes back-firing in carburetor?

A. (1) Weak inlet valve spring, not letting valve close properly. (2) Inlet valve leaks; needs grinding. (3) Weak gasoline mixture. (4) Spark too

far retarded. (5) Valves may not be timed correctly.

Q. What is the cause of a smoky exhaust?

A. If it is a heavy black smoke it is due to too much gasoline being fed by the carburetor; but if the smoke is blue it shows there is being too much oil fed to the engine.

Q. What causes carbon deposits to form in the cylinder?

A. The chief cause is the overfeeding of oil. The following will also cause carbon to form in the cylinders: A choked muffler, causing back pressure; too rich a mixture, causing incomplete combustion, or too defective ignition.

Q. What is meant by a short circuit?

A. A bypass of comparatively small resistance around any portion of a circuit, by which so much of the circuit passes as virtually to cut out any circuit connected therewith, and so prevent it from receiving an appreciable current.

Q. Why is a muffler used on a gasoline engine?

A. To deaden the noise of the exhaust gases.

Q. Why is it necessary to keep the muffler free from carbon deposits and soot?

A. If the muffler is not kept clean it will tend to increase back pressure, causing lack of power.

Q. What causes a muffler shot?

A. (1) Exhaust valve partly opened. (2) Cylinder missing fire and unburnt gases pass into the muffler, which are ignited from the next exhausted charge. (3) Too late a spark. (4) Weak batteries. (5) Muffler full of carbon and soot. (6) Faulty construction of muffler.

Q. What causes an engine to kick backward when cranking?

A. (1) An overheated cylinder. (2) Having the spark lever too far advanced. (3) Carbon deposits in combustion chamber become incandescent, causing premature ignition.

Q. What effect has cold on gasoline?

A. The gasoline does not vaporize so readily in cold weather and should be supplied with extra heat.

Q. If an engine gets overheated should cold water be poured over the outside of the cylinders to cool them?

A. No; to pour cold water over the cylinders while in such condition would be apt to crack them.

Q. What are the symptoms of an overheated engine?

A. The engine will begin to pound and knock, while the water in the radiator will steam.

Q. What is liable to result from an overheated engine?

A. Lubricating oil burnt up; the pistons expanding from the heat and binding to the cylinders and the connecting rod bearings to the crankshaft; possibly a broken crankshaft.

Q. What should be done when the engine gets overheated?

A. It should be stopped at once and allowed to cool, while the engine is turned over occasionally by hand to keep the pistons and bearings from binding.

Q. What is the cause of poor compression?

A. Poor compression is caused by (1) leaky valves. (2) Spark plug loose. (3) Piston rings stuck or broken. (4) Insufficient lubrication. (5) Valve cap loose. (6) Cracked piston. (7) Scored or cracked cylinder. (8) Weak valve springs. (9) Valves may not be timed correctly.

Q. If an engine has poor compression does it affect its power?

A. Yes; to a very great extent.

Q. How can you tell if an engine has poor compression?

A. By turning the engine over by hand and notice if it takes the same pressure to pull over each compression stroke.

Q. What is a remedy for a clutch that takes hold too quickly?

A. A few drops of neat's-foot oil put on the clutch surface.

Q. If a clutch slips what should be done?

A. By washing the clutch surface with gasoline it will sometimes be relieved, or the clutch spring may need tightening.

Q. How can a sticky valve in the engine be remedied?

A. By soaking it with kerosene.

Q. What causes choking of the air intake?

A. Valve not properly adjusted, valve spring too weak, or engine may be cold.

Q. If your clutch would not disengage while running the car what would you do?

A. I would put on the brakes and throw off the switch.

Q. If motor keeps running after throwing off the switch what is the cause?

A. The most common cause is pre-ignition, due to overheating of motor; short circuit or switch not working properly.

Q. How can carbon be removed from the combustion chamber without taking off the cylinders?

A. By soaking the carbon with kerosense or one of the good preparations on the market made for

that purpose, and allowing to stand for some time. Removing the valve caps and spark plugs, a scraper could be inserted through the openings and the carbon pushed out.

Q. How can carbon be removed from under the piston rings?

A. The only way this can be properly done is by removing the pistons from the cylinders and the rings taken off the piston and thoroughly scraped.

Q. Define the word pre-ignition.

A. Self-firing; the motor continues to run after the current is shut off.

Q. What is the cause of self-firing?

A. Overheated motor, probably due to insufficient lubrication; circulating pump not working, lack of water in radiator, carbon deposits in combustion chamber, using low gear too much, driving with spark too far retarded, muffler choked, radiator tubes or water jackets stopped up, fan not working properly, carburetor not properly adjusted.

Q. What is a commutator?

A. It is a device for changing the direction of electric currents.

Q. What is a volt meter?

A. It is an instrument for measuring the electrical motive force or difference of potentials between any two points in a circuit.

Q. What is an ammeter?

A. It is an instrument for measuring the quantity of electricity flowing in a circuit.

Q. What is an ampere?

A. The practical unit of electric current, the current being the rate of flow.

Q. What is a volt?

A. A volt is the unit of electric motive force.

Q. What is a hydrometer?

A. An instrument for determining the specific gravities of liquids.

Q. What is meant by specific gravity?

A. The ratio of weight of a body to the weight of an equal volume of some other body taken as a standard or unit. A standard for solids or liquids is usually water.

Q. What is a magneto?

A. A magneto is an electric device used to supply electricity for ignition on a gasoline engine.

Q. Is the current generated by the magneto direct or alternating?

A. Alternating current, reversing its direction of flow rapidly.

Q. By what means is it changed to a direct current?

A. By the use of a commutator.

Q. Where is the commutator located on the magneto?

A. It is located on the armature shaft.

Q. What is meant by direct current?

A. An electric current constant in direction as distinguished from an alternating current.

Q. What is alternating current?

A. An electric current that alternately flows in opposite directions.

Q. Of what use is a distributer?

A. By its use any number of cylinders may be ignited from a single coil.

Q. What is the difference between the high- and low-tension magnetos?

A. The low-tension magneto consists of a number of permanent horseshoe magnets and an armature rotating between their poles, and as the armature cuts

the "lines of force" of the magnets an electrical current is set up in its coils and is collected by a suitable brush. The magneto consisting of a contact-maker and an induction coil or a contact-maker, single coil and a high-tension distributer using regular spark plugs with the contact-maker and distributer mounted on the magneto, is then generally called a high-tension magneto. The name applied, however, is electrically incorrect, as the magneto really generates only a low-tension current, which is then transformed by a single coil. A regular high-tension magneto has a second winding on its armature which takes the place of a coil, so that the current, when it is collected for distribution, is already at a high tension.

Q. In connection with what system of ignition is the low-tension magneto generally used?

A. The make-and-break system.

Q. What system of ignition generally uses the high-tension magneto?

A. The jump-spark system.

Q. What two ignition systems are considered the most practical?

A. The high- and low-tension systems.

Q. What other names are these two systems known by?

A. The high-tension is known as the jump-spark system, while the low-tension is called the make-and-brake system.

Q. What is known as the dual system of ignition?

A. The dual ignition employs both magneto and battery with one set of spark plugs.

Q. What is the end of a wire in a circuit called?

A. A terminal.

Q. What is a switch?

A. It is a device for throwing on and off the electric current when so desired.

Q. How many positions has a switch?

A. Generally three—magneto, battery and off positions.

Q. How may a broken trembler blade on the coil be temporarily repaired?

A. By making a blade from a piece of corset steel or clock spring.

Q. By what method can the fuel efficiency be increased?

A. By a proper handling of the car and a correct adjustment of the carburetor.

Q. How would you extinguish a fire in the carburetor?

A. By throwing sand or earth on it, or smother it.

Q. What is the result that all carburetors and vaporizers attempt to secure?

A. They attempt to mix the right proportions of gas and air before it is drawn into the cylinders for combustion.

Q. What is the needle valve?

A. It is that part of the carburetor that controls the supply of gasoline.

Q. What is the effect of turning the needle valve in or out?

A. By turning the valve in it reduces the flow of gasoline, while turning it out allows more gasoline to flow into the carburetor.

Q. What is the correct position of the needle valve?

A. The correct position is when the engine develops the most power and speed with the least consumption of gasoline.

Q. What use is the auxiliary air valve?

A. At high speed the motor requires a greater proportion of air than when running at low speed, and for this reason an auxiliary air inlet is provided.

Q. What is known as the flusher or tickler?

A. It is that part of the carburetor used on some cars to cause the gasoline to flow for starting purposes.

Q. On what part of the car does the throttle act?

A. On the carburetor.

Q. State how shutting off the air supply can have the effect of producing an explosive suitable for starting a cold engine.

A. By shutting off the air nothing but gasoline is drawn into the cylinders, which will help considerably to start a cold engine, but the air should be turned on again after the engine is started.

Q. What is the spray nozzle?

A. It is that part of the carburetor that the gasoline passes through to the mixing chamber in the form of a spray.

Q. Does the spray nozzle ever give trouble?

A. Yes; dirt is very often liable to get into the nozzle and stop the supply of gasoline.

Q. What would you do if the spray nozzle got dirt into it?

A. In some cars it would be necessary to take the nozzle out, but in others the carburetor can be drained by unscrewing a cap from the bottom.

Q. What is the mixing chamber?

A. It is that part of the carburetor that the gasoline spray and air meet to be mixed and formed into a gaseous vapor.

Q. Will the throttle affect the quality of the mixture?

A. No; it does not affect the quality. It affects the quantity.

Q. Why is a filter used on some cars in the pipe leading from the gasoline tank?

A. For the purpose of straining out any dirt that may be in the gasoline.

Q. What trouble will follow from using too rich a mixture?

A. The combustion chamber will become carbonized, fouling of the spark plugs and heating of the engine, causing loss of power.

Q. Why is it necessary to supply extra heat to the carburetor in cold weather?

A. Because gasoline does not vaporize so readily in cold weather. It is generally heated by allowing hot water to run around the carburetor through a water jacket.

Q. If the motor refuses to start on account of it being too cold how may the carburetor be heated to induce starting?

A. By pouring hot water or by placing hot cloths around the carburetor, being careful not to allow any of the water to get into the gasoline.

Q. What is the difference between the selective and the progressive types of transmission?

A. The difference is mainly in the method of operating the speed changes. In the selective transmission the speed desired may be selected and changed to it at once without passing through any other speed. With the progressive style the continuous or progressive movement of the gear-shifting lever gives in succession the speed from the lowest to the highest. If the car had four speeds and the low gear was in, and the highest was desired, it

would be necessary to pass from low to second, to third, then into the high gear.

Q. Of what use is the transmission?

A. It is that portion of an automobile's mechanism which transmits the power of the motor to the rear or driving wheels.

Q. What is the nature of this mechanism?

A. It is a combination of parts arranged in such a way that by means of a suitable lever different gear ratios or speed ratios may be obtained.

Q. Why is this necessary?

A. Because the construction of a gasoline engine is such that its power depends largely on its speed, and, therefore, for heavy duty the ratio of gearing to the driving wheels must be raised, thus increasing the power.

Q. How is such a transmission constructed or arranged?

A. There are several different kinds of transmission, the most common kind being known as the sliding gear transmission. In this device rows of gears are arranged on parallel shafts, and speed changes are made by sliding different gears into mesh with one another while turning at high speed.

Q. Is not this operation destructive to the gears?

A. Not so much as one would think. Still, there is always the liability of breakage or stripping the teeth, especially if one be not expert. There is also a certain amount of wear on the gear and much noise is sometimes caused by shifting or changing speeds.

Q. Are there other kinds of transmissions?

A. Yes; there are individual clutch transmissions, in which the gears are always in mesh and their action controlled by a system of clutches, each speed

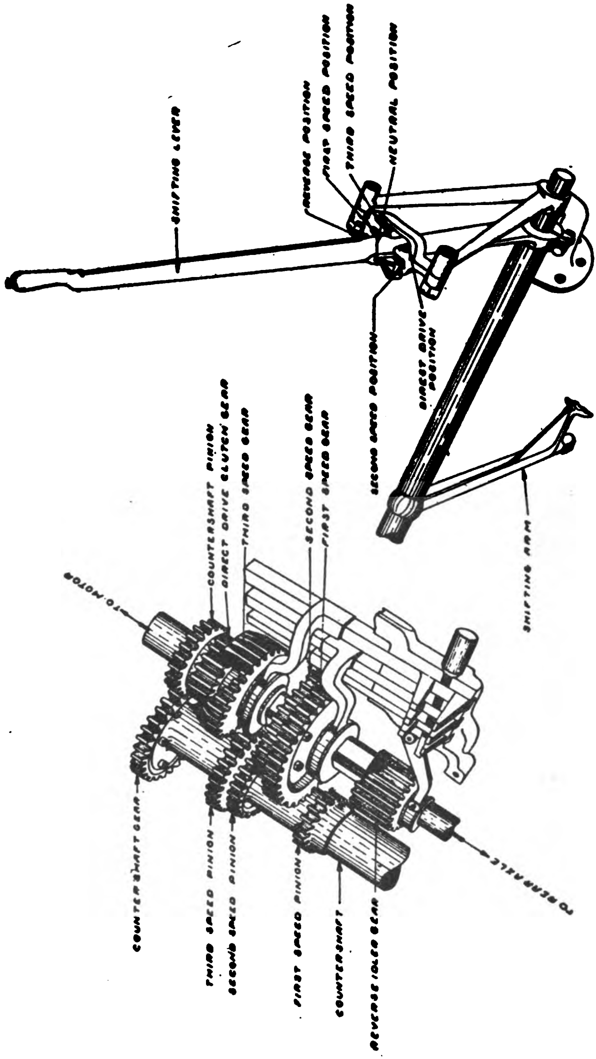


FIG. 19. *Diagram of Peerless Transmission*

ratio being operated by a separate clutch. Of these individual clutch transmissions the most common is known as the planetary, in which the gears are arranged in circles, revolving around a central gear like planets around the sun.

Q. What attention does the transmission require?

A. It is necessary to grease it frequently, for, if allowed to become dry, the transmission gears will soon be ruined.

Q. Are most modern automobiles similar in design?

A. Yes; there is great similarity in a general way among most modern automobiles.

Q. What is the difference between the sliding gear and the friction types of transmission?

A. Instead of a gear box containing a number of toothed gears or cogwheels, the power is transmitted by friction, which is to say by a rolling contact of one round disc against another placed perpendicular to it.

Q. How many speeds may be had from a friction transmission?

A. Any number desired; twenty or more.

Q. Can this type of transmission be used as a brake?

A. Yes; the reverse can be used as a brake, and is more efficient and far quicker in its action than any brake can possibly be. By its use the rear wheels can be whirled backward while the car is still running forward.

Q. What is the direct drive?

A. When driving on direct, it is from the crankshaft without passing through any intermediate gears.

Q. What should be done when changing from one gear to another?

A. The clutch should always be disengaged.

Q. What rule should be observed before placing the reverse gear in on a sliding gear transmission?

A. The car should be brought to a full stop first.

Q. Of what use is the differential gear? And how does it work?

A. It consists of gears arranged so as to equalize or differentiate the movement of two adjoining shafts or axles, allowing equal driving power to be transmitted to each shaft or axle while rounding or turning corners, as in an automobile, when one axle must travel faster than the other. By this means two different speeds in two different parts of the axle are provided for.

Q. What is a "floating" rear axle?

A. A floating type rear axle is a rotating rear axle of the type in which the wheels are carried on a non-rotating tube, within which the driving axle rotates, it being connected with the wheels by jaw clutches, or similar means not involving positive engagement. Thus the rotating part does not carry the weight.

Q. What is known as a dead axle?

A. One that carries weight only.

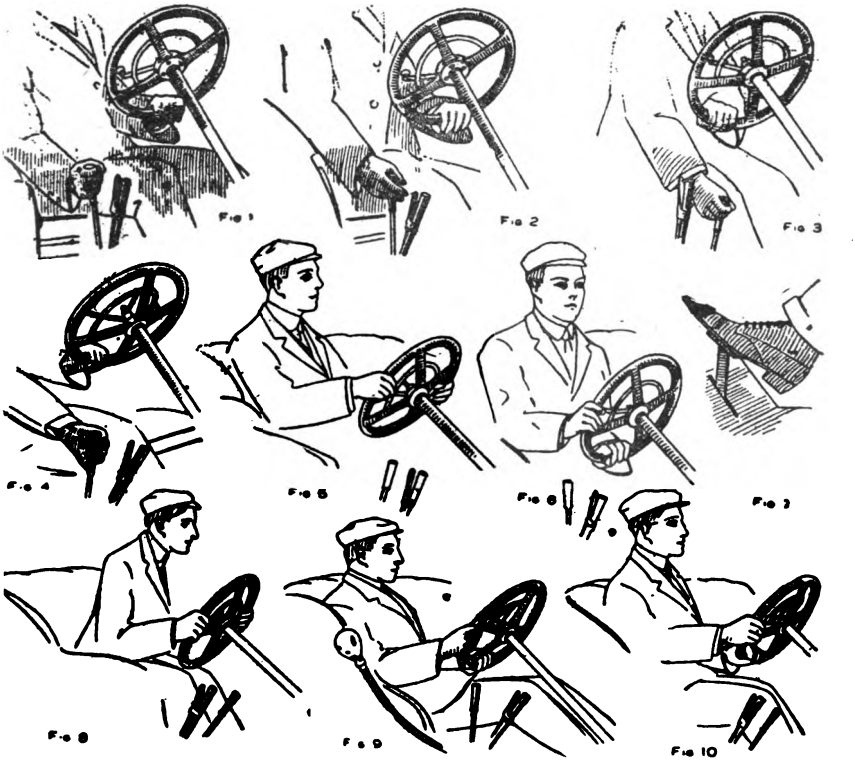
Q. What is a live axle?

A. One having parts that turn the driving wheels in addition to carrying the weight.

Q. When an automobile turns a corner, do the wheels on one side turn faster than the wheels on the other side?

A. Yes.

Q. On which side do the wheels turn faster in rounding a corner?



1—Fierce Grip a Bad Method; 2—Correct Hold for Forward Movement; 3—Finish of Forward Movement; 4—Alternative Grip Suitable for Many Gears; 5—Awkward Hold of Wheel: 6—Proper and Comfortable Hold; 7—Wrong Foot Position; 8—Nervous, Uncomfortable Position; 9—Careless, Lounging Position; 10—A Correct "Seat"

A. The wheels on the outside, or the ones farthest from the curb.

Q. Is it necessary to supply some means of driving the rear wheels so that in case there is more resistance to the turning of one wheel than there is to the turning of the other?

A. Yes.

Q. Describe briefly how this can be accomplished.

A. The driving wheels of an automobile are arranged so that they may turn independently of each other. This is accomplished by using a divided axle, which is driven by a number of gears, known as the equalizing, compensating or differential gear.

Q. Where is the differential located?

A. It is located in the center of the rear axle.

Q. How would you know if the differential was broken?

A. By the failure of the rear wheels to turn after the clutch was let in turning the driving shaft, and not the rear axle.

Q. What is the proper way to pass a moving vehicle going in the same direction?

A. I would give the proper warning by sounding the horn and pass on the left side of it.

Q. In coming to intersecting roads what would you do?

A. I would slow the car down and blow the horn, and keep to the right.

Q. If you met another vehicle and there was a doubt as to the right of way, what would you do?

A. I would stop and let the other vehicle have it.

Q. After you had passed a moving vehicle going the same way would you turn right in front of it immediately?

A. No; I would run some distance before turning to the right of the road again.

Q. Has an automobile the right of way, and is a pedestrian supposed to get out of your way when you blow the horn?

A. No; every one has the same rights on the public roads.

Q. Would you attempt to run a motor car after taking a drink of any alcoholic beverage?

A. No; it would be more than unjust to others; it would be a crime.

Q. How would you pass a horse-drawn vehicle on a narrow road, going in the same direction?

A. I would pass very slowly on the left side of it, and if I saw the horse was frightened and the driver might lose control of it I would stop my car and motor, if necessary, until such time as I saw that there would be no chance of a possible serious accident.

Q. How would you turn a corner or curve?

A. I would never cut a corner. I would slow down, keep well to the right and blow the horn.

Q. Would you pass a moving vehicle going in the same direction around a corner or curve?

A. No; I would wait until the other vehicle was around the curve, and saw that the road was clear before trying to do so.

Q. Would you try to pass a moving vehicle in a cloud of dust?

A. No; I would wait until the view was unobstructed, as another vehicle may be coming from the opposite direction.

Q. What is the proper side to pass a moving vehicle coming from the opposite direction?

A. Pass on the right-hand side.

Q. What is the proper side to pass a moving vehicle going in the same direction?

A. Pass on the left side of it.

Q. How would you pass a trolley car that is standing still?

A. I would slow up and blow the horn, and if the car was discharging passengers I would come to a stop; if compelled to pass on the left side of it I would run very slow and be ready to stop in an instant, as some one may step from behind the car in front of the machine.

Q. How would you drive on slippery or sandy roads?

A. I would run slow and use great caution, because the car cannot be easily controlled when the roads are in such a condition.

Q. Would you hold the center of the road if another vehicle is trying to pass you?

A. No; I would keep well to the right, and give them the same courteous treatment as I would expect from them.

Q. Would you run away in case you were in an accident?

A. No; I would stop and offer help if I could; it would be cowardly and inhuman to run away.

Q. How would you leave a car on a hill unattended?

A. I would put the brakes on and turn the front wheels to the curbstone, or put a block under them.

Q. What is the proper way to make a right-hand turn into another street?

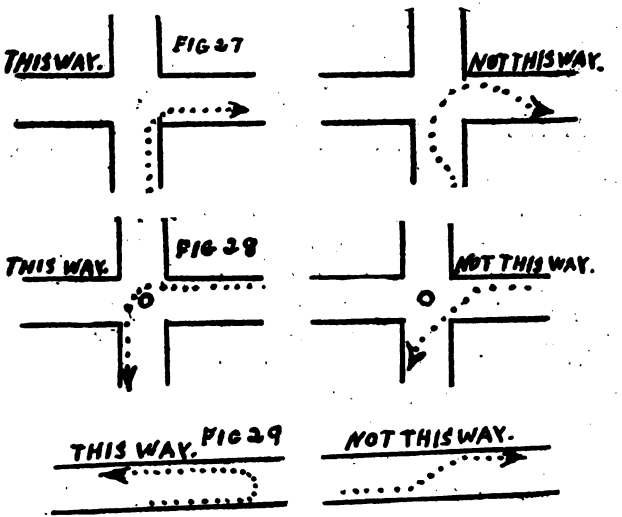
A. I would turn the corner as near the right-hand curb as possible. See Fig. 27.

Q. What is the proper way to make a left-hand turn into another street?

A. In making a left-hand turn I would turn around the center of intersection of the two streets. See Fig. 28.

Q. What is the proper way to cross from one side of the street to the other?

A. Before crossing I would look back or hold up the hand to warn any one approaching. Then turn to the other side, with the right-hand side of the machine to the curb. See Fig. 29.



Q. In coming to a stop or slowing up what signal would you give those behind?

A. I would raise the hand vertically.

Q. Do you know what vehicles have the right of way?

A. Yes; the Fire Department, police patrol, fire patrol, United States mail, emergency repair and ambulances.

Q. Would you occupy any street as to interfere with or interrupt the passage of other vehicles or street cars?

A. No.

Q. In waiting at the curb, would you give place to a vehicle about to take on or let off passengers?

A. Yes.

Q. What is a public highway?

A. Any highway, county road, state road, public street, avenue, alley, park, parkway or public place in any county, city, borough, town or village.

Q. Would you display the number plates of more than one State at any time?

A. No.

Q. How many lights should be displayed and what time should they be lighted?

A. Display at least two white lights on the front, to be visible at 200 feet. One light on the rear, which shall display a red light visible from the rear. The rear lamp must also throw a white light on the license plate, visible for at least 50 feet in the direction from which the machine is proceeding. The lamps should be lighted at least from one-half hour after sunset to one-half hour before sunrise.

Q. Of what use is a speedometer or autometer?

A. To register the speed of the car in miles per hour and the distance traveled.

Q. What is the tonneau of an automobile?

A. Rear seats.

Q. On entering a strange city, and you were in doubt about the traffic regulations, what would you do?

A. Upon entering the city I would stop and ask the first police officer I saw for instructions.

Q. Are there any cities that require blowing of the horn at every street intersection?

A. Yes.

Q. If a licensed chauffeur has the car out on business should he allow any friend of his to drive the car?

A. No; it would be unlawful.

Q. If you had to leave the car in the street all night, what would you do?

A. I would leave a light on the front and rear.

Q. What would you do if you were witness of an accident?

A. I would stop and offer help if I could, and give my name to the party as a witness to the accident.

Q. Would you stop your car in front of a fire hydrant?

A. No; I would not stop a car within ten feet of one.

Q. Name the important parts of a car that should be examined with a view to safety before starting out.

A. The steering gear, brakes, nuts on wheels, tires, spring clips and body bolts.

Q. What would you do in approaching a railroad track?

A. I would run slowly and be cautious. If my view of the tracks were obstructed I would have some one to go ahead and warn me of any approaching danger before attempting to cross the tracks.

Q. When driving in the country at 20 miles an hour could you be arrested?

A. Yes, if the road was congested to such an extent that you endanger the rights of others on the road you could be arrested for reckless driving.

Q. Could you be arrested when driving at 12 miles an hour in the city?

A. Yes; if the streets were crowded you may be considered driving recklessly.

Q. When driving in the city when is it compulsory to stop the car?

A. When receiving a signal from a police officer at the street crossings.

Q. Could you be arrested for not obeying such a signal??

A. Yes.

Q. If you were driving across a railroad track, and stalled the motor, what would you do?

A. If I did not have time to start the engine or push the machine off the tracks I would try to flag the train. If too late, and a smash-up was certain, I would direct all occupants of the car to run in the direction of the approaching train, so as to be away from the flying débris when the machine was struck.

Q. Define the word motor vehicle?

A. It includes all vehicles containing three road wheels or more that are propelled by any power other than muscular power, except such vehicles as run only upon rails or tracks.

Q. What is a chauffeur?

A. Any one operating or driving a motor vehicle as an employe or for hire.

Q. Is it unlawful to have the license tags carried on the machine in a way as to allow them to swing?

A. Yes; they should be securely fastened to prevent swinging.

Q. May a chauffeur permit any other person to possess or use his license or badge?

A. No; nor shall any person use a license or badge belonging to another person.

Q. May an unlicensed chauffeur drive a motor vehicle?

A. No.

Q. May a chauffeur drive an automobile while his license is suspended or revoked?

A. No.

Q. May a person be punished for making a false statement in his application for license?

A. Yes; he would be guilty of a misdemeanor.

Q. What are the main things necessary for a motor vehicle's equipment so as to comply with the law?

A. To have a thoroughly efficient brake system, a proper signaling device, correct number of lights, an exhaust muffler, and proper license tags to comply with the law in which State you are driving.

Q. Define the word friction.

A. Resistance to the motion of a body, caused by contact with the surface upon which it moves.

Q. How may friction of the bearings and all moving parts on an automobile be reduced to a minimum?

A. By having all moving parts properly lubricated.

Q. Describe briefly how lubricating reduces friction.

A. When moving parts are properly lubricated the metal surfaces are separated by a continuous film of oil.

Q. What is generally used to lubricate a sliding gear transmission?

A. A high-class grease free from acid.

Q. What is used to lubricate the differential?

A. The same quality grease.

Q. What is used to lubricate the motor?

A. An oil that is specially prepared for gasoline motors should be used.

Q. How is the transmission lubricated?

A. They are generally lubricated by inserting grease through a hand hole in the top of the case.

Q. How are the differential gears lubricated?

A. The same way as the transmission.

Q. Is grease used on the engine bearings and cylinders?

A. No; a good cylinder oil is used for the engine.

Q. What may cause insufficient lubrication in the oiling system?

A. Not sufficient oil in tank; oil pump not working properly; oil pipe may be broken or stopped up; oil pipes air-bound; not enough pressure; oilers not adjusted properly; inferior oil.

Q. May graphite be used for lubricating an automobile?

A. Yes; it can be used on bearings and chains. It may also be used for lubricating the motor to some extent, but may cause clogging the valves.

Q. What effect does the weather have on the lubrication oil?

A. Lubricating oil will thicken up in cold weather, requiring a different adjustment of the oilers.

Q. What attention should be given the oiling system?

A. The oil pipes and conduits should be kept free from deposits. See that there are no broken or cracked pipes and always have plenty of oil in the tank.

Q. How are the wheels lubricated on most cars?

A. The wheels have to be removed and packed with grease; on some cars by filling the hub cap

with grease and then replacing the cap forces the grease into the bearings.

Q. Of what use is a radiator on automobiles?

A. For cooling the water.

Q. Do all gasoline engines have radiators?

A. No; those that are air-cooled do not require any water.

Q. Does the water enter the top or bottom of the radiator on a car that has a forced circulation?

A. It enters the top.

Q. Name the most common types of pumps that are used for circulating.

A. The rotary type, gear, wing or centrifugal pumps.

Q. State what two methods are used in cooling the cylinders?

A. Air cooling and liquid cooling.

Q. State a mixture that will prevent freezing of the water at a temperature above zero; and below zero.

A. At a temperature above zero use 30 per cent. wood alcohol; below zero use 40 per cent wood alcohol.

Q. What use is the circulating water pump?

A. By forcing circulation of the water it regulates the temperature of the water in the jackets.

Q. Describe briefly the air-cooling system of a motor.

A. A fan driven by the motor forces a constant supply of cold air around the outside surface of the cylinders.

Q. Describe briefly the forced circulation for cooling.

A. By means of a pump; the water passes from the pump and is forced through the water jackets,

then into the top of the radiator, out the bottom and back through the pump again.

Q. Describe briefly the thermo-syphon cooling system.

A. By having a tank of water situated above the level of the water jackets, as the water in the water jackets becomes heated the cold water in the tank forces the hot water out of the jackets into the tank, causing an automatic circulation.

Q. Why is cooling of the cylinders necessary?

A. In order to properly lubricate the motor; to prevent pre-ignition.

Q. Of what use is a fan on a gasoline engine?

A. To assist in drawing air through the radiator for the purpose of cooling the water.

Q. What would be the effect if the engine is kept too cool?

A. Less power will be developed by the engine.

Q. What is considered the proper temperature to have the cylinders for efficient work?

A. They should be about 350 degrees Fahrenheit.

Q. Why is cooling the engine necessary?

A. (1) To permit proper lubrication. (2) To prevent pre-ignition.

Q. What advantage has the air-cooled engine over the water-cooled engine?

A. There is no trouble of any kind from water leaks and no fear of freezing in the winter time and bursting of cylinders.

Q. What disadvantages has the air-cooled engine?

A. Failure to keep it cool enough for proper lubrication.

Q. What precautions would you take to prevent the water in the radiator and engine from freezing in cold weather?

A. It is well to mix an anti-freezing solution with the water; to keep the engine and radiator covered when standing idle in the street.

Q. What would be the result if the water in the radiator or water jackets is allowed to freeze?

A. It would cause the bursting of the water jackets and the radiator.

Q. What precaution should be taken to prevent freezing of the water while the car is standing outside in cold weather when an anti-freezing solution is not used?

A. By covering the radiator with a robe or coat. This will retain the heat for a considerable time.

Q. What is the function of the intake valve?

A. It allows the proper amount of explosive mixture to enter the motor.

Q. What is the function of the exhaust valve?

A. To provide an outlet for the burnt gases.

Q. How many revolutions does the crankshaft make to one opening of each valve?

A. Two revolutions.

Q. What is the most common type of valve used?

A. The poppet or mushroom type, with the edges of the valve beveled.

Q. What is the function of the timing gears?

A. They regulate the opening and closing of the valves and the ignition to occur at the proper time.

Q. What attention should be given the valves?

A. They should be examined at frequent intervals, and if found leaky and pitted should be ground in with fine emery.

Q. What operates the valves?

A. The valves are operated by a cam shaft?

Q. Is the valve chamber a part of the combustion chamber?

A. Yes.

Q. What is the rate of revolution of the camshaft to the crankshaft?

A. The camshaft makes one revolution to two of the crankshaft.

Q. Which center should the inlet valve close on?

A. It should close at the end of the suction stroke.

Q. When should the inlet valve open?

A. It should open near the end of the exhaust stroke.

Q. When should the exhaust valve open?

A. It should open at the end of the explosion stroke.

Q. In grinding valves is a complete circular movement correct?

A. No; it would be disastrous.

Q. How should the valves be ground?

A. They should be ground by using a backward and forward movement, lifting the valve up often to change its position.

Q. How can the valves be tested to see if they are opening and closing at the proper time?

A. By inserting a wire through the pet cock in the top of the cylinder; then turn the engine over by hand and watch the valves to see if they close and open at the proper time. The flywheels on some cars are marked to indicate the proper time the valves should open and close when the marks are opposite the pointer that is placed above the flywheel.

Q. What effect has wear on the valve stem or the lifts?

A. It affects the time of opening and closing of the valves.

Q. Do the valve springs open or close the valves?

A. Close them.

Q. What opens the valves?

A. The valves are lifted open by the cams on the camshaft.

Q. Of what use are the valve spring caps and keys?

A. To hold the tension of the valve spring and to keep it in position.

Q. What holds the valves on their seats?

A. The valve springs.

Q. How is an automatic intake valve opened?

A. By the suction produced by the piston.

Q. Are mechanically operated valves usually provided with some means for changing slightly the time of opening or closing or adjusting the lift of the valve?

A. Yes; on most cars the valve lift is provided with an adjustment.

Q. Should there be a space between the valve stem and the push rod?

A. Yes.

Q. About how much space should be between the valve stem and the push rod?

A. About the thickness of a business card.

Q. When should this clearance occur on both valves?

A. On the compression and working strokes.

Q. How could you determine whether or not such clearance actually exists?

A. By sliding a small card between the valve stem and the push rod while the engine is not running and the valves closed.

Q. What is the effect of a sticking valve stem?

A. It causes it to close slowly and sometimes it does not close at all.

Q. What is the indication that valves need grinding?

A. Lack of power, poor compression, failure to start engine on spark after standing idle a short time.

Q. What is a cam?

A. It is a projection on a shaft to produce reciprocating motion.

Q. What is a cam used most for on automobiles?

A. It is used to open and allow the valves to close at the proper time.

Q. What constitutes timing a motor?

A. To have the valves open and close and to have the spark to occur at the proper time.

Q. What part of a motor is required to move in time with the movement of the piston?

A. The valves.

Q. What causes heating of wheel bearings?

A. Bearings adjusted too tight; insufficient lubrication.

Q. What are the two most common bearings used for wheels?

A. The ball and the roller bearings.

Q. What is a thrust bearing?

A. One that is intended to sustain end thrust.

Q. What is an annular ball bearing?

A. The annular ball bearing consists of three elements—the balls and the two races.

Q. Do ball bearings require lubrication?

A. Yes.

Q. What is a storage battery? Describe it to the best of your ability.

A. The storage battery, so-called, although really it does not store electricity, but the energy of an electric current, is caused to produce electrolytic decomposition to such a nature as to independently produce a current on the removal of the electrolyzing current. The battery is a combination of cells which

consists of plates of lead immersed in diluted sulphuric acid, and are charged by the passage through the liquid from one plate to another of an electric current from some external source. The charging current produces an electrolytic decomposition of the inert liquid between the plates, depositing the electro-positive radicals on the plates connected with the negative terminals of the source, and the electro-negative radicals on the plates connected with the positive terminals. On the cessation of the charging current and the connection of the charged plates by a conductor outside the liquid, a current is produced which flows through the liquid from the plates covered with the electro-positive radicals to that covered with the electro-negative radicals, or in the opposite direction to that of the charging current. When this discharge is thoroughly effected, the cells become inert, and will furnish no further current until again charged by the passage of a current from some external source again.

Q. How can an exhausted dry cell battery be temporarily restored?

A. By boring holes in the pitch at the top of the cell and moistening the interior with a solution of sal ammoniac, salt water or vinegar.

Q. What care should be taken in placing a storage battery in position?

A. Care should be taken so as not to tilt the battery and spill the acid, or jar or knock it.

Q. When does a battery deteriorate the most?

A. When it is not in use.

Q. Are dry cells intended for constant service?

A. No; they are made to be used for intermittent service.

Q. Which is considered the most reliable for ignition on a gasoline motor, dry cells or a storage battery?

A. A storage battery.

Q. Why is a storage battery considered more reliable than a dry cell?

A. Storage batteries are an advantage over dry cells in that they will at least maintain a steady pressure or voltage during the life of a charge, and they do not drop in voltage or pressure while being used, or until their amperage, or quantity of current originally put into them is consumed.

Q. How are the positive and negative poles of a battery generally marked?

A. They are marked + for positive and — for negative. On some batteries they are marked P for positive and N for negative.

Q. In connecting the wires to the battery what care should be taken?

A. To see that the wires are connected to their proper poles; have the terminals tight and free from dirt.

Q. When a storage battery will not furnish enough current for proper ignition can it be recharged?

A. Yes; they can be recharged by the passage through the liquid from one plate to another of an electric current from some external source.

Q. What is a primary battery?

A. One that generates electric current within itself.

Q. What is meant by resilient?

A. It means to bound, to spring, to leap, rebounding, as applied to a rubber tire, distinguishing from

a dead or hard-riding tire. A tire of resiliency is easy-riding, active, bounding and speedy.

Q. State the causes of tire blow-outs.

A. Punctures, cuts, bruises, wheels out of alignment, tires not properly inflated, overloading, speeding and faulty tire construction.

Q. In patching an inner tube would you place the patch on the tube while the cement is wet or damp?

A. No; I would wait until both surfaces were thoroughly dry before applying the patch.

Q. How are the tube and patch treated before applying the cement?

A. The tube and patch should be cleaned of all dirt and grease by washing them off with a little gasoline, then rough both surfaces with a piece of sandpaper.

Q. Could an inner tube be repaired with a piece of friction fabric?

A. No; a patch of rubber should always be used, as friction fabric is not airtight.

Q. How can a tire casing or shoe be temporarily repaired?

A. By placing a blow-out patch over the hole on the inside of the hole. Another should also be placed on the outside of the shoe. These patches are considered necessary parts of a car's equipment.

Q. What expense is considered one of the chief items of car maintenance cost?

A. The tires.

Q. What rule, if followed, will materially decrease tire bills?

A. Keep the tires inflated to the proper riding pressure.

Q. What should be done to a small cut in the casing?

A. It should be properly repaired before serious harm is done. There are several preparations on the market for such purposes.

Q. What would be the result if the small cuts are not closed?

A. The dirt from the road forces itself into such cuts, gradually working in between the rubber tread and the fabric portion of the tire, causing them to separate. When the separation starts the entire tread will go to pieces with remarkable rapidity.

Q. If one did not have a blow-out patch what could be done with a bursted tire?

A. If one had an extra old shoe that was of no value a section could be cut out of it and placed over the hole in the damaged shoe. A temporary repair to a casing, that will sometimes last a long time if done properly, is to wrap a piece of rope around the hole on the outside of the tire for a distance of six inches on each side of the blow-out. Secure the ends to the spokes of the wheel and inflate tire.

Q. How should spare casings be carried?

A. They should be carried in casing covers, which should be dark in color, as sunlight has an injurious effect on rubber.

Q. How should extra inner tubes be carried?

A. They should be carried in a tube bag and never allowed to lie loose in a box, as they are liable to chafe.

Q. What is the proper way to store and care for tires during the winter?

A. The tires should be removed from the wheels and washed carefully with soap and water. Wrap them in strips of paper or cloth and store in a dark place in which the temperature should be about 40 degrees Fahrenheit.

Q. If the car is not to be used for a considerable length of time what would you do to the tires?

A. The wheels should be jacked up, and let out most of the air, leaving only about five pounds in each tire. This will keep the tubes in shape and also keep them soft and pliable.

Q. What would be the result to the tires if the wheels do not run true?

A. No matter how slightly the wheels are out of true they are always running at a slight angle to the direction traveled by the car, which produces a severe grinding between the tread and the road, which takes off the rubber like a grindstone. No tire will last long running under these conditions.

Q. State a way how one could determine if the wheels are true?

A. By using a straight-edge and measure between the felloes of the wheel or the edges of the rims on the wheels at the point directly in front of the front axle. Mark this distance carefully and measure in the same way across the wheel directly back of the front axle or opposite from where the first measurement was taken. The difference between these two distances will be the amount that the wheels are out of true.

Q. Are quick stops injurious to the tires?

A. Quick stops, while occasionally necessary, are always injurious to the tires.

Q. How can the evil effects of quick stopping be reduced to a minimum?

A. By perfect adjustment of the brakes, so that the rear wheels will take up equal portions of the strain.

Q. Is turning corners at high speed considered skillful driving?

A. No; it is a very expensive method of demonstrating skillful driving, as it produces the same result to the tires as quick stopping does.

Q. What effect will overloading have on the casings?

A. Overloading a tire will break down the fabric in the side walls and eventually a blow-out will occur.

Q. Why do blow-outs occur sometimes while the car is standing still or running on a perfectly smooth road?

A. Blow-outs like that occur from hitting a sharp obstruction with such force that the inner fabric is bruised and weakened, possibly torn, and eventually it gives way and a blow-out occurs, perhaps days or weeks after the orginal injury was received.

Q. What is the weakest part of a tire?

A. The side walls, for here most of the bending action takes place. The more the side walls are kneaded or bent the sooner they will break down and separate. If a tire is run partially inflated this kneading action is violent, and the tire is bent sharply every time it hits an obstruction.

Q. What causes rim cuts on the tires?

A. The chief cause is riding the tire without sufficient air pressure. Another reason is riding the tire on a rim that is not true, that has been somewhat battered or misshapen.

Q. What keeps a tire from creeping on the rim?

A. The tire is kept from creeping by friction. The air pressure in the tire forces the bead of the tire against the clinch of the rim, causing a friction of the two surfaces, although some tires are held by tire lugs.

Q. What holds the inner tube from creeping?

A. The valve stem on the inner tube is provided with a nut, and when the nut is drawn tight it holds the inner tube in place.

Q. What is known as the running gear?

A. The wheels, axles, etc., of the car, distinguishing from the body.

Q. What is the most common type of automobile wheel used?

A. The artillery wheel.

Q. Why is it called an artillery wheel?

A. From its use on gun carriages.

Q. What kind of spokes are used on this wheel?

A. Wooden spokes, made from the best quality of wood.

Q. How are the spokes fastened to the hub?

A. They are bolted to the iron or steel hubs; the outer ends of the spokes are mortised into a wooden felloe.

Q. What part of an automobile is considered dead load?

A. All weights below the springs are dead load.

Q. State the advantages of a shaft drive.

A. It is quiet, clean and convenient.

Q. What disadvantages has the shaft drive?

A. It is complicated and hard to repair.

Q. What advantages has the chain drive?

A. It is efficient, flexible and permits of proper balance, easy to repair.

Q. What disadvantages has the chain drive?

A. Noisy, breakage of chains, constant adjusting and oiling of chains.

Q. Where are the universal joints located?

A. They connect the driving shaft to the transmission and differential; another universal joint is

also used to connect the transmission with the clutch.

Q. Why are universal joints necessary?

A. They take up any difference in alignment of the different parts.

Q. On a chain-driven automobile how often should the chains be cleaned?

A. Every month.

Q. What is the proper method to use in cleaning the chains?

A. Remove the chains and allow them to soak in kerosene for several hours; then wash them off with gasoline. Dry chains and soak them in a mixture of hot grease and graphite. Remove chains from grease, hang up and allow the grease to cool; then wipe off the excess grease.

Q. What are the main points in the care of an automobile?

A. Keeping every part well lubricated and having all parts properly adjusted, and a careful handling of the car.

Q. How may a broken body spring be temporarily repaired?

A. By placing a block of wood between the frame and spring and securing it by wrapping it with a rope or wire.

Q. Would you run the engine to its maximum while the car is standing idle?

A. No; as it puts an unusual strain on the different parts.

Q. What is an important thing to remember before cranking an automobile engine?

A. To be sure the spark lever is fully retarded, so as to prevent a back kick.

Q. If a car is to be stored in a cold place, what precautions should be taken?

A. All water should be drawn off to prevent freezing and possibly bursting the radiator and cylinders.

Q. In placing pistons into the cylinders what care should be taken with the rings?

A. Care should be taken not to break them and to see that they are in their proper positions.

Q. What precautions should be taken to prevent overheating of engine?

A. Run with spark lever advanced to proper position. Do not race engine when using low gear. See that water pump is working properly. Keep radiator and water jackets free from obstructions and full of water. Keep fan belt tight. Muffler should be cleaned occasionally. Have carburetor adjusted properly.

Q. Name several parts of an automobile.

A. Axle, bearings, body, brakes, cams, carburetor, chains, clutch, coil, connecting rods, crank case, crankpins, crankshaft, cylinder, differential, equalizer, exhaust pipe, flywheel, frame, magneto, muffler, piston, radiator, steering knuckle, spark plug, body spring, starting crank, steering wheel, throttle, timer, transmission, universal joint, exhaust valve, wheels.

Q. What precaution should be taken in putting in a gasket?

A. Not to break it; to have center of gasket removed and have the flanges clean.

Q. What precautions should be taken with an acetylene light?

A. The gas should not be allowed to flow unlighted in a closed room, as it would endanger the life of any living creature. The burners and pipes should be kept free from dust and carbon. Also to

see that there is no leak of gas around the generator, gas tank or piping.

Q. Is kerosene good for cleaning the inside of the cylinders?

A. Yes; kerosene should be injected into the cylinders and allowed to stand for several hours. It will help to remove the carbon deposits from the combustion chamber and free the piston rings.

Q. What rule should be observed when it becomes necessary to remove separable parts from an automobile?

A. To have all parts properly marked to facilitate reassembling.

Q. What is a brake?

A. A piece of mechanism for retarding or stopping motion.

Q. What is meant by skidding?

A. For a car to slide sidewise.

Q. What causes skidding?

A. A sudden application of the brakes while driving on a wet or muddy roadway.

Q. How can you ordinarily prevent a car from skidding?

A. By careful driving and applying the brakes gradually.

Q. Which axle are the driving wheels on?

A. Rear axle.

Q. On what part of the car do the brakes act?

A. They act on either the hub or rear wheels—transmission or differential.

Q. By what method are the brakes worked?

A. They are operated by either a foot pedal or hand lever.

Q. Is there any way of equalizing the same pressure on each brake?

A. Yes; many cars are equipped with an equalizer.

Q. What is an equalizer?

A. A device to insure the equal action of both brakes, so that they will act with the same tension, thus preventing the car from skidding or swerving.

Q. What is a contracting band brake?

A. One that acts on the outside of the brake drum.

Q. What is an expanding band brake?

A. One that acts on the inside of the brake drum.

Q. How should the brakes be used?

A. They should be applied as gradually as possible.

Q. Which brake is most commonly used?

A. The foot brake.

Q. If oil and grease get on the brake band surface, what would be the result?

A. The brakes would not hold enough to stop the car.

Q. What should be done?

A. The brakes should be taken off and cleaned at once. If this should happen where one did not have the time to take the brakes off gasoline could be squirted around the brakes to wash the grease off, or sand thrown on the brake bands will help considerably.

Q. Should the brakes be applied while the clutch is in?

A. No.

Q. What symptoms show the brakes need adjusting.

A. Failure to stop the car properly and a desire for the car to skid.

Q. How can you get better braking force in going down a steep hill?

A. By putting the gear lever in the low speed and throwing the switch off, then let the clutch in. This will hold the car back considerably. You can also use the brake as well.

Q. How often should the brakes be examined?

A. They should be examined daily.

Q. When would you use the brakes?

A. For stopping or retarding the motion of the car.

Q. Why is asbestos used on some brakes?

A. On account of its high resistance to heat.

Q. What is important about the steering gear?

A. It should be cleaned, oiled and thoroughly examined at frequent intervals to see that all parts are tight and in place.

Q. Describe the worm and sector irreversible steering gear.

A. An irreversible steering gear must be turned from the steering wheel, and cannot be moved by pushing on the front wheels.

Q. Is this an advantage?

A. Yes; for the driver does not feel any motion of the steering wheel when the front wheels go over inequalities in the road.

Q. How may a broken steering rod be temporarily repaired?

A. By fastening a piece of pipe or an iron rod against the broken parts and wrapping them together with rope or wire. If the pipe or iron rod could not be secured, a strong branch of a tree would answer.

Q. Why are buffer springs used on most cars at the ends of the steering connecting rods?

A. Their use is to absorb the shocks caused by rough roads.

Q. What is the best method of filling a gasoline tank?

A. It is well to place a piece of chamois in the funnel for the purpose of straining out all floating particles, as well as water, from the gasoline. Fine wire gauze may be used as a strainer, but it will not, of course, exclude water that may be mixed with the gasoline.

Q. Would you hunt for a gasoline leak with an open light?

A. No; the result of finding it may be disastrous.

Q. Would you pour gasoline out in a room where there is an open light?

A. No; because the vapor of gasoline will be drawn to any nearby fire, candle, gaslight or lamp.

Q. Would you leave a gasoline vessel uncovered?

A. No; because the currents of air draw out the vapor.

Q. Would you smoke while filling the gasoline tank?

A. No.

Q. Would you fill the gasoline tank entirely full?

A. No; I would always leave an air space at the top.

Q. Will water put out a gasoline fire?

A. No; it is useless for such a fire.

Q. What will put out a gasoline fire?

A. Sand, earth or ammonia will smother a gasoline fire if confined in a small place.

Q. How could you tell the amount of gasoline that is in the tank at night?

A. By using an electric or pocket flashlight, or by inserting a stick down in the tank.

Q. How is gasoline obtained?

A. Gasoline is a product of crude petroleum.

Q. How may a broken gasoline pipe be temporarily repaired?

A. By placing a piece of rubber tubing over the broken ends.

Q. How may a small hole in the gasoline pipe be temporarily repaired?

A. By forcing a piece of soap into the hole and wrapping a soaped rag around it.

Q. In what style of motor is the crank case used for compression of the mixture?

A. The two-cycle motor.

Q. Why is this motor called two-cycle?

A. Because it completes the series of operations in two strokes of the piston instead of four; hence the name two-cycle.

Q. State how the two-cycle motor completes the series of operations with two strokes of the piston.

A. The upward stroke of the piston produces a vacuum in the crank case. The crank case being in communication with the carburetor, the mixture is first drawn into the crank case. On the return or downward stroke of the piston the charge is compressed in the crank case. Just before the piston reaches the end of this stroke it uncovers a port in the cylinder which is in communication with the crank case by means of a by-pass into the cylinder. As the mixture enters the cylinder it strikes a deflecting plate on the end of the piston, forcing the gas toward the cylinder head, so that it will not pass directly across and out of the exhaust port. On the next or upward stroke the mixture is compressed between the piston and the cylinder head and ignited and exploded the same as a four-cycle motor. Before the piston reaches the end of the explosion stroke and before the intake port is uncovered the exhaust port is uncovered and the ex-

haust passes out into the muffler. The stroke also forces the mixture from the crank case into the cylinder with such force as to clear the cylinder of all burned gases. You can readily see that the compression stroke for the cylinder is also the suction stroke for the crank case, and the explosion stroke is the compression stroke for the crank case.

Q. In how many revolutions of the flywheel are the four operations performed in a two-cycle motor?

A. One revolution.

THE FOLLOWING QUESTIONS AND ANSWERS REFER TO THE ELECTRIC VEHICLE.

Q. What is the first thing the driver of an electric carriage should learn?

A. He should first learn to read the meter.

Q. What does the meter indicate?

A. The amount of electric motive force (volts) and the flow of current will be indicated on the meter in amperes.

Q. Why is reading the meter so important?

A. If one will familiarize himself with the reading of the meter he will never get left anywhere by reason of an absolute discharge of the batteries.

Q. What rule should be observed before placing the controller key in position?

A. Have the controller lever at off position.

Q. In starting an electric carriage should the controller lever be pushed to the extreme forward position at once?

A. No; the controller lever should be moved forward slowly and start the carriage gently, after which the lever can be moved steadily forward to the stop.

Q. If the carriage is started in this manner what will it accomplish?

A. By so doing it will avoid the jerk and jump that is unpleasant, and will save current.

Q. What is the most important thing a driver of an electric vehicle should figure on?

A. The driver should figure at all times to save the current.

Q. State several ways to save current in driving.

A. By shutting the current off and coasting a hundred feet to the place at which you desire to stop. Shut the current off and coast around all corners. Coast down all hills with the current off. Considerable current can be saved in this manner.

Q. Can a good driver get more mileage out of an electric vehicle than the inexperienced or the indifferent driver?

A. Yes; a good driver will easily get ten miles longer run.

Q. What is a resistance box?

A. A box containing a number of coils for reducing the flow of electric current.

Q. Define the word resistance.

A. Electric ratio between the electric motive force of a circuit and the current that passes therein.

Q. What is a compound wound motor?

A. It is a motor whose field magnets or poles are excited by more than one circuit of coils.

Q. What is a multi-polar motor?

A. It is a motor of more poles than two; the multiple of two.

Q. What is a bi-polar motor?

A. A motor of two poles only.

Q. Of what use is the controller lever?

A. The controller governs the current of electricity from the battery and permits the driver to change the speed of the vehicle at will.

Q. What does it mean when it is said the battery is discharged?

A. The point at which the battery is discharged or empty.

Q. What is a volt ammeter?

A. It is an instrument combining a volt meter and ammeter.

Q. What is an ohm?

A. It is the practical unit of electric resistance.

Q. Of what use are the brushes on an electric vehicle?

A. They are used for conveying the electricity of the armature through the commutator.

Q. What is the function of a commutator in a dynamo electric machine?

A. In a dynamo electric machine the currents change or alternate their direction as many times in one revolution of the armature as there are poles in the machine. The commutator is that part of the machine that causes these currents to flow in one and the same direction in the external circuit.

Q. In what kind of weather will the mileage of an electric vehicle be materially reduced?

A. Freezing weather.

Q. What rule should be observed when an electric vehicle is to be left standing alone?

A. Always remove the controller key.

Q. Do the batteries keep in better condition by using them daily or by leaving them stand idle?

A. The batteries are in better condition if used daily.

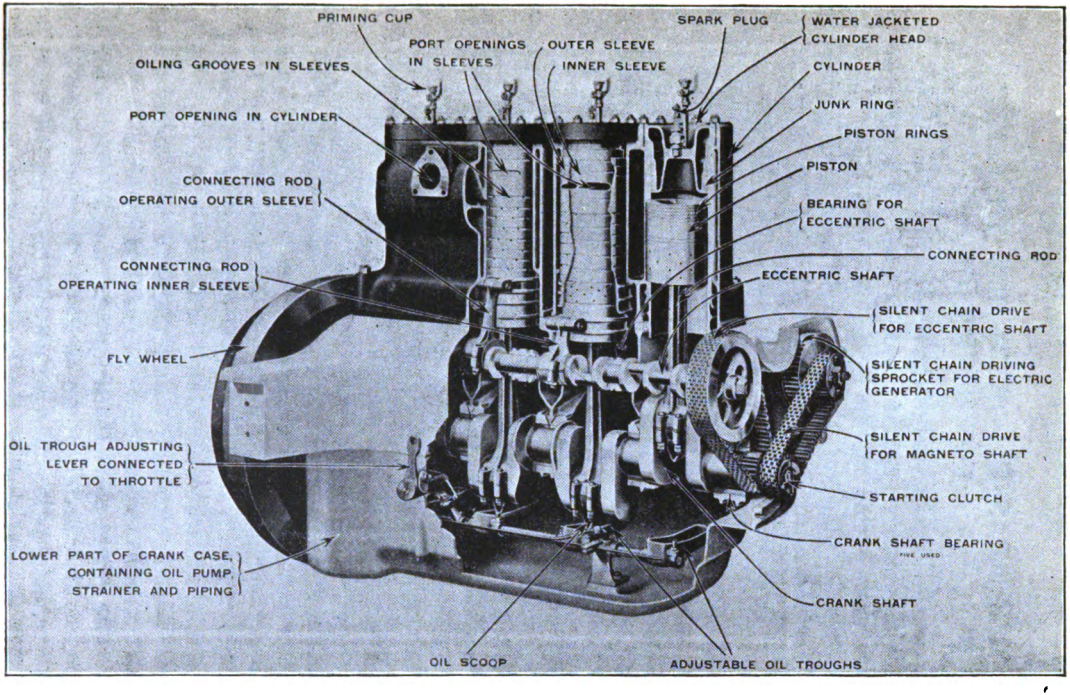
Q. Is it injurious to a battery to leave it stand discharged for a length of time?

A. Yes; very injurious.

Q. Will a sandy, muddy or hilly road use more current than a smooth and level road would?

A. Yes; considerably more.

Besides the questions and answers in this book, one should also study the automobile laws of the State in which they wish to secure a license. If in doubt as to the laws and traffic regulations of any State or city, write to the proper state or city authorities for detailed information regarding the law, which will promptly be sent you.



CUTAWAY VIEW OF STEARNS-KNIGHT MOTOR, SHOWING WORKING PARTS, WITH DESCRIPTION.

—Courtesy F. B. Stearns Company, Cleveland, Ohio

INCREASED POWER DUE TO VALVE CONSTRUCTION.

In the latest model of the Stearns line, the Stearns-Knight, a new type of motor is used. The greatest feature of this motor is the use of sliding sleeve valves in place of the old style cam and spring-operated valves. This valve mechanism was invented and patented by Chas. Y. Knight, of Chicago.

This improvement in the design and operation of the valves has eliminated all noise in this part of the mechanism of a gasoline motor. Valve action consists of two concentric sleeves sliding up and down between the piston and cylinder walls. These sleeves open and close wide slots or ports opening directly into the combustion chamber through which the inlet and exhaust gases pass. These sleeves are moved up and down by small connecting rods from a crank or eccentric shaft in about the same manner as the slide valves of a steam engine are operated. This shaft is driven by a silent chain and the usual noise of timing gears is eliminated. Throughout the whole travel of the valve, their control and quietness is absolute. The old style valves were lifted from their seats by a cam and brought back again by a heavy spring. The noise of the cam striking the valve when it started to lift and that of the valve striking its seat when closed by the spring, cannot be eliminated, although many more or less successful attempts have been made to muffle this noise.

The quietness of the Knight-type valve mechanism proves its reliability, for noise in any mechanism is a sure indication of wear or the tendency to wear. With the old system, the clashing parts were hardened to minimize the wear, and enclosed to muffle

the noise. The new system *eliminates the cause* of the trouble by a radical *change in design.* The wearing in of the reciprocating sleeves adds to the efficiency of the motor instead of destroying it. There are no valves to grind, no cams and rollers to wear, no springs to weaken, no adjustments to make. The discarding of these parts has simplified the operating mechanism and has made the cylinder castings less intricate. The whole mechanism is but another instance of where correctness of design has produced simplicity and reliability.

The increased power produced by these sleeve valve motors has shown to a remarkable extent the relative inefficiency of the best type of poppet valve motors. At low engine speeds this is not so noticeable, for the cam and spring operated valves are then at their best. At high speeds, however, their action is more or less unreliable and the "timing" or opening and closing of the valves is uncertain. The sliding valves are positively controlled throughout their entire motion and no change in timing and consequent loss of power at high speeds is possible. At high engine speeds the travel of the exhaust and inlet gases is exceedingly fast and many restrictions to their passage to and from the combustion chamber results in a loss of power. An unrestricted passage for these gases is not possible with the poppet valve arrangement. With the sleeve valve, however, an ideally shaped combustion chamber is formed and the passages to and from this chamber through the ports in the sleeves are absolutely direct. No style of valve mechanism has yet been invented which produces as accurate and efficient functioning as that of the present motor.

INSTRUCTIONS FOR OPERATING AN AUTOMOBILE.

The first thing the novice should do before attempting to drive an automobile is to familiarize himself with the different parts of the car he is to drive. Before starting the engine see that the gasoline tank is full; also see that the radiator has water in it and the oil tank is full. See that the batteries are in good condition, and charged to proper point of efficiency. Assuming now you are ready to start the engine, first see that the gear shifting lever is in a neutral, or idle, position (see Fig. 19), and the hand brake is set. On most cars this lever will also throw the clutch out, so that there is no connection between the engine and driving mechanism. Insert switch plug, in center of coil box (which is generally on the dash), and throw the switch on the battery side, which brings the battery into action. See Fig. 25.

If the car is equipped with a magneto, then the other side of the switch would bring the magneto into action. With some magnetos you can start the engine by cranking, but others you cannot. Assuming you are starting on the battery, with the switch on that side, make sure the spark lever is set to the full retard position (see Fig. 16), and the throttle is open about a quarter way (see Fig. 16). Push in the starting crank at its lowest point, and with one hand give crank a quick upward pull. If the engine does not start at once crank it several times; if the engine is cold or has been standing

any length of time it may be necessary to flood the carburetor or put a little gasoline into the cylinders through the relief cocks. After you have the engine started, advance the spark half way, and regulate the throttle so that the engine does not race. It would be better before taking the car out to jack the rear wheels up and take your seat behind the steering wheel and practice shifting the gears to their different positions (see Fig. 2); also familiarize yourself with the clutch and brake pedals, spark and throttle levers and the hand brake, that you may be able to use the proper one without the least hesitation or doubt. Do this until you feel that you are competent to take the car out. Having taken your seat behind the steering wheel, release the emergency, or hand, brake. (If the car has a planetary transmission, throw the low speed in first, speeding the engine up at the same time, having the car moving fairly well; then throw into high speed.) On a car that has a sliding gear transmission you first press down on the clutch pedal with your foot, and place the shifting lever in the notch for low or first speed gear (see Fig. 19); let the clutch pedal up gently, which allows the clutch to engage, and the car will move forward; then push down on clutch with foot, and put the shifting lever in the next notch, or second speed gear, and let the clutch up in the same way as shifting to first speed gear. You keep on shifting in this manner until you have the lever in the last notch, or high speed gear. With the shifting lever in the high speed notch the changes of speed then are entirely controlled by the throttle and spark levers, which levers are placed on the steering post or over the steering wheel, as shown in Fig. 16, at the maximum

speed the spark should be advanced to its maximum point and the throttle should be wide open.

When you desire to run at the lowest speed, when driving with the high speed gear in, the spark lever should be advanced a quarter to half way, and the throttle should be closed as much as possible, and still allow gas enough to be fed to the engine to turn it over. The operation of the spark and throttle levers you will find will be governed by conditions, and the use of them is nothing more than a matter of practice. If you have the spark advanced too far it will cause a pound or knock in the engine, because the explosion has taken place before the piston has completed its upward stroke. The movement of contact at the commutator, and the flashing of the spark at the spark plug, which is screwed into the cylinder, are practically instantaneous. But there is an appreciable time between the spark and the time the gas becomes completely ignited. When you have the engine running at a high rate of speed to get the best results the spark should take place when the piston is on its way up, but the moment the engine starts to knock retard the spark until the noise stops. To reverse the car, bring it to a full stop first, push down on the clutch pedal and put the shifting lever in the notch for the reverse, then let the clutch in gently and the car will move backward. To stop the car, close the throttle, push down on the clutch pedal, then apply the foot brake. If it is necessary to stop suddenly you can also apply the hand brake, but never stop suddenly unless it is necessary, for if the brakes are applied to the maximum they will lock the wheels, which is very injurious to the tires. After the car has come to a stop place the shifting lever in a neutral or idle

position and put the hand brake on. You could now leave the car if you wished to, with the engine still running. There would be no danger of it starting off itself if these directions are carried out. If you wish to stop the engine, throw the switch off, which is on the center of the coil box, and the engine will come to a stop.

In climbing a hill that cannot be negotiated on the high speed gear you would have to change to a lower gear. A good plan in climbing a hill is to speed the engine up before you reach the bottom, and as the engine slows up, owing to the added load, and if the engine begins to knock or pound, retard the spark. If you see the engine is running too slow and is apt to stop, then you will have to shift to a lower gear. When it becomes necessary to change gears allow the speed of the car to come down to that of the engine. Never shift the gears when the engine is at top speed. Of course, if the car will not climb the hill on that gear then shift to the next lowest, and so on, until you see what gear you will need. This will only be found necessary on the very steepest hills. After sufficient practice has been had the driver will be able to shift gears at will on any hill. In descending a hill put the shifting lever in the notch for high gear and press down on the clutch pedal, with your foot, which disconnects the engine from the driving mechanism, which will allow the car to coast. As the car reaches the bottom of the hill do not let the clutch in until the car and engine are running at the same speed. Another way in descending a hill which will also utilize the engine as an additional brake, is to put the low gear in before descending, then let the clutch in; as the car starts down throw off the switch. This

will hold the car back considerably. If it is necessary to use the brake also you can do it without releasing the clutch while running with the switch off. I do not advise descending a hill in this manner unless the hill is very steep and you feel that your brakes may not hold the car.

Learning to steer an automobile is nothing more than a matter of practice. When you first take the car out it would be better to get on a road or street where there is very little traffic. Start off on first gear until you see that you have the car running straight, then change to the next gear, as already described, until you get the lever in the notch for high gear. Never take your eyes off the road to look at the shifting lever while doing so, as you will lose control of the car and possibly run into the curb or another vehicle. This may seem simple, but it has been the cause of a great many accidents. That is the reason I advise before taking the car out to jack the rear wheels up and practice shifting the lever to its different positions. It will not take long to learn shifting to the different positions without looking at them. In steering an automobile, and you want to turn to the right you turn the wheel to the right; or if you wish to turn to the left you turn the wheel to the left, but do not jerk the wheel suddenly; move it gradually. Practice steering on a straight road or street before attempting to turn corners, and always take them very slowly. Do not practice fast driving until you feel sure you are competent to control the car, as it may be disastrous. Great care should be taken in driving over an asphalt street that is wet. It is all right when driving straight ahead, but in making a turn or coming to a stop is where you will have to be very

careful, as the wheels are apt to skid or slide. It is well to run very slow when the streets are in this condition. In coming to a stop use the brakes sparingly and apply as gradually as possible. If they are applied suddenly it will cause the car to turn completely around and may cause a collision. In turning a corner when the streets are wet you will have to be very careful. Never follow another fast-moving vehicle in a cloud of dust or try to pass it unless the view is unobstructed, as some one may be coming from the opposite direction. Never cut a corner, but always keep to the right of the road and blow the horn; or do not cross intersecting roads without slowing down and blowing the horn. Do not pass a trolley car or another vehicle that is standing still without slowing up or coming to a stop and giving warning. If compelled to pass them, keep your car under control and be ready to stop instantly, as some one may walk out in front of you. Do not think that all that is necessary to do is to blow the horn to warn others; slow down to see if they hear you. They may be deaf or frightened, and may do the wrong thing. Bear in mind that the foot traveler, even if he is not on a crosswalk, has the right to use the street, and is not obliged to get out of your way. Your full duty is not performed when you blow your horn or other device for signaling. It is your legal duty to avoid touching the pedestrian. This sometimes can only be accomplished, particularly if the pedestrian is old or infirm, or a child, by bringing your car to a full stop. Whenever there is a doubt as regards the right of way, let the other fellow have it. Never run an automobile after taking a drink of any alcoholic beverage; it is more than unjust to others;

it is a crime. Always keep your brain and heart at work for the good of others and so of your own. If you lack either brains or heart it is a positive crime against humanity for you to drive an automobile.

RIGHT AND WRONG WAYS OF DRIVING AUTOMOBILES.

The mere matter of driving an automobile in the sense of getting it to a given point and back again without an accident is a comparatively easy and simple accomplishment, even to a beginner, with but little practice. But, according to the automobile dealer and repairer, there is a right and a wrong way, an easy and awkward way, and sometimes a safe and dangerous way of carrying out a number of necessary operations. These ways, which are the little tricks of the trade, distinguishing a really good driver from an amateur, are explained in the drawings. Fig. 1, for instance, shows a fierceness of grip on the gear lever which is faulty with many drivers. Unless there is some defect in the mechanism actuated by the movement of the lever, making the latter excessively stiff to operate, such a grip is not only unnecessary, but a distinct disadvantage, tending to encourage undue roughness and force in changing the gear.

The correct handling of the lever is shown in Figs. 2 and 3. It gives all the grip and certainty of movement that is required, and there is no implied necessity for great force, as in Fig. 1. Fig. 2 shows the correct hold for the movement, and Fig. 3 shows the finish of the movement, or ready for the backward pull. Fig. 4 shows an alternate method of holding the lever for a movement back and outwardly

across the gate that is particularly suitable for some gears, especially when the sliding shaft of the lever is liable to bind in crossing the gate. Figs. 5 and 6 show two ways of holding the steering wheel, the former being considered awkward, while the latter is far more natural and comfortable. Also, when the wheel is held in such a manner as shown in Fig. 6, and it becomes necessary to reach for the lever when it is in its forward position, there is no tendency for the movement of the body to cause a pressure of the left hand on the wheel that might turn it and swerve the automobile from its path. Fig. 7 defines a position of the foot that is not to be recommended when the clutch is "in" and the brake "off." The heel, if not the whole of the foot, should be kept firmly on the floorboard, for, by resting the weight of the foot on the clutch pedal, a large amount of unnecessary friction and wear takes place at the clutch fork. Also there is a liability that the clutch may sooner or later be caused to slip.

Figs. 8 and 9 show awkward and ungraceful positions in "seats." The former, apparently a nervous and uncomfortable seat, is frequently adopted by beginners, while the latter shows an inclination to carelessness much to be decried. Fig. 10 shows a seat that is not awkward and stiff, nor careless, but it is a comfortable seat that adds to certainty of proper manipulation of steering gear and controls.

TRANSMISSION.

At Fig. 19 is shown the selective type of transmission as used on the Peerless cars. The speed of the Peerless is regulated by a system of shifting gears which run on the main shaft and a counter shaft, and gives the operator four speeds forward

and one reverse. These gears are located in the transmission case just back of the clutch, and are controlled by the shifting lever at the side of the car. You will see from the diagram at Fig 19 that this lever can be thrown into five notches for the five speeds. When the lever is in neutral position between the notches none of the gears are meshed and the motor runs free. In the first speed the driving is through counter-shaft pinion, counter-shaft gear, first speed pinion and first speed gear. Second speed is through counter-shaft pinion, counter-shaft gear, second speed pinion and second speed gear, and third speed is through counter-shaft pinion, counter-shaft gear, third speed pinion and third speed gear. High speed is through direct drive gear meshing internally with third speed gear, thus making a direct drive. For the reverse the driving is through the counter-shaft pinion, counter-shaft gear, first speed pinion and reverse idler gear that reverses first speed gear.

WHY THE MOTOR STOPS.

If the motor should stop the same as when the switch is thrown off, the trouble may be caused by a loose or broken wire, fouled spark plugs, short circuit, broken or loose parts on circuit breaker or igniter, switch plug loose or not in position, switch off or not making a contact, igniter fingers not snapping or coming together. If the motor should miss fire before stopping, the trouble then would be either from a weak battery, short circuit, vibrators out of adjustment, loose connections, springs on igniter fingers weak. If the stop is preceded by back firing in the carburetor, the trouble then would be from an empty gasoline tank, gasoline pipe stopped

up, or gasoline cock shut off, dirt in carburetor, water in gasoline. If the car seems to drag before stopping it may be from insufficient lubrication causing some part to get hot and bind, probably the bearings or pistons, the brakes may not be released, or the bearings in the wheels may have worked tight or dry.

The above mentioned troubles one will generally meet with in operating an automobile. If the time is taken to study the above subjects, any one would soon be able to tell just what the trouble is the moment the motor stops. In case one should break a crankshaft, piston, connecting rod, camshaft, cam, gears, shaft, differential or any other part, they will in nearly every instance show for themself without much trouble in hunting them.

HOW TO ADJUST THE SPARK COIL.

Ignition batteries are capable of furnishing a definite quantity of electrical energy, according to the National Carbon Company. This capacity is sufficient to run a motor car several thousand miles, if properly used. This economy of current depends on whether or not the sparking apparatus is of good design, and if the coil is properly adjusted. The importance of the latter is not sufficiently recognized by operators of motor cars and power boats. An idea of its importance may be obtained from the fact that a battery capable of running an automobile several thousand miles with properly adjusted coils may not be capable of running even several hundred miles with poorly adjusted coils. By observing the following rules the tension of the vibrator on the spark coils may be adjusted to the minimum

rate of consumption of battery energy consistent to the proper operation of the engine:

(1) Make certain that the contacts on the spark coil are clean and even, and not too much pitted. (If contact points become deeply pitted or rough they should be smoothed down by using a fine file.)

(2) See that spark plugs are clean and free from short circuits.

(3) While the engine is not running, turn the crank until one of the spark coil units is thrown into position in the battery circuit and its vibrator set in motion.

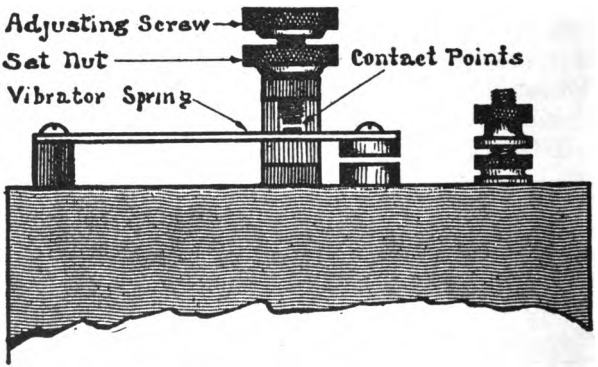


Fig. 25.—A Conventional Sketch of Single Jump Spark Coil

(4) Lessen the tension on the vibrator by means of the adjusting screw (see Fig. 25) until the contacts are separated and the vibrator ceases to move; then increase the tension just enough to cause the vibrator to be set in motion again. Secure the adjusting screw.

(5) Proceeding in like manner, adjust the tension of the vibrator of each of the other spark coils to the minimum consumption of battery energy.

(6) Crank the engine. If engine refuses to run, or if it runs in an irregular manner, increase the tension on each vibrator by giving the adjusting screw a very slight turn downward.

THE CARBURETOR.

At Fig. 15 is shown a Peerless carburetor. The information herein given we hope will make plain many features that the inexperienced find difficult to understand. At Fig. 16 is shown the throttle control. The gravity system of gasoline supply from the tank to the carburetor is used on Models 27 and 28 of the Peerless cars. The gravity system requires no watching or maintenance of air pressure by means of a hand pump or other device, and the motor may be started without any reference to the length of time that may have intervened since it was last stopped. A second or auxiliary tank is built in the top of the main gasoline supply tank. This auxiliary tank may be brought into use at a moment's notice by turning the handle of the two-way valve located at the base of the fall-board within convenient reach. The chief purpose of the auxiliary tank is for use in emergencies. The gasoline filter is located between the main gasoline tank and the carburetor. In case it is desired to drain and clean this filter, the valve handle regulating the flow of gasoline from tanks is turned to position "off" and the shut-off valve between the filter and the carburetor is closed. Remove the sediment tube cap located at the base of the sediment tube and allow a little gasoline to flow from the tank. It takes very little gasoline to thoroughly clean the filter and sediment tube. To drain the carburetor, shut off the

gasoline supply under the gasoline tank and drain through the filter, as described above.

Entering the carburetor, the gasoline first passes through the float chamber, where its level is automatically regulated by the float. As this float rises it actuates the two balance levers at the top of the chamber and pushes down the plunger in the center, thus closing the needle valve gasoline inlet at the bottom. Connected with the float chamber is the spray nozzle, the tip of which is in the center of a surrounding air passage, one end of which communicates with the outer air, the other end with the engine cylinders. The air is sucked through a brass screen of fine mesh, past a wing valve to the spraying throat by the powerful suction produced by the movement of the close-fitting pistons in the engine cylinders. Since the nozzle tip is located in the constricted area of the spraying throat the gasoline is "sucked out" and readily vaporized by the strong rush of air. The amount of air is regulated by the small lever on the dash, which controls the wing valve to the main air supply. Moving this lever to the left closes the valve and thereby increases the richness of the mixture. As the air enters the surrounding air passages and passes the nozzle it sucks up a small quantity of gasoline, breaking it into a fine spray of gaseous mixture in the mixing chamber. This mixture is carried from the carburetor to the combustion chambers of the motor through the "Y" inlet manifold shown in the drawing.

The quantity of the gasoline is automatically regulated. As the motor increases its speed, there is a corresponding increase in the velocity of the inrushing air and a greater quantity of the mixture is drawn into the motor. At high speed the motor re-

quires a greater proportion of air than when running at low speed, and for this reason an auxiliary air inlet is provided, which is located at the extreme top of the carburetor. When the motor is running at high speed and the regular supply is sufficient to fill the vacuum created in the cylinders and inlet pipes, the force of this vacuum automatically opens the valve of the auxiliary air inlet.

A single seated throttle operating vertically is located at the upper extremity of the mixing chamber. The gas is free to move up or down through the throttle, because, being hollow, there is nothing to obstruct its passage. In order to remove the throttle it is made to slide in a sleeve, which may be unscrewed from the carburetor body. The valve is operated by a throttle stem, through a system of levers and rods from the throttle knob on the steering wheel, also by the accelerator pedal. Besides these, the speed is controlled by the centrifugal governor.

If the muffler gives out a strong gasoline odor it shows that the mixture is too rich, and the air lever on the dash should be regulated to give the carburetor more air. Too rich a mixture will cause an engine to "miss" explosions, because of sooty or "foul" spark plugs. Too weak a mixture will make it miss because of the lack of gasoline for combustion. A weak mixture may be caused by wrong adjustment of the air lever on the dash or by dirt in the carburetor or supply pipe. Try regulating the air lever, and if this is not effective, drain the carburetor in the way we have described. Occasionally it may happen that dirt will get into the end of the nozzle, but this can be very easily taken out by re-

moving the plug below it and then unscrewing the spray nozzle.

In starting your car, especially when it has been standing for some time, so that the motor is cold, it may be found necessary, on account of the lack of air current passing through the mixing chamber, to make the gasoline overflow from the nozzle by taking off the small brass cap on cover of float chamber and raising the small brass rod. Should this not prove effective close the air valve by means of the lever on the dash. In this way there will be nothing but gasoline vapor drawn into the cylinders.

The tension of the conical valve spring on the auxiliary air inlet is regulated by the two locknuts immediately above the spring. The lift of the auxiliary air valve is regulated by the two locknuts inside the spring. This tension and lift of air valve may need regulating after a time, how much must be determined by experience. Other than the adjustments we have mentioned, the carburetor should not be touched, as it is thoroughly adjusted before leaving the factory.

TIMING THE SPARK OF A MAGNETO.

To obtain proper ignition it is evident that the sparking time must coincide with that position of the armature at which there will be the greatest volume of electrical energy in the windings, and the time of break between the points must be synchronous with the instant that the piston is at top compression stroke, or its firing point, with the engine at normal speed. In motor car engines the firing point is variable, though generally the spark will take place ahead of center, from one-quarter to three-quarters of an inch, depending upon the stroke

of the piston. The average will be three-eighths to one-half inch. When the proper firing point is known the crankshaft is revolved until the piston in the cylinder about to fire is in position, which can best be determined by inserting a piece of wire through a compression cock or spark plug opening, as shown at Fig. 12.

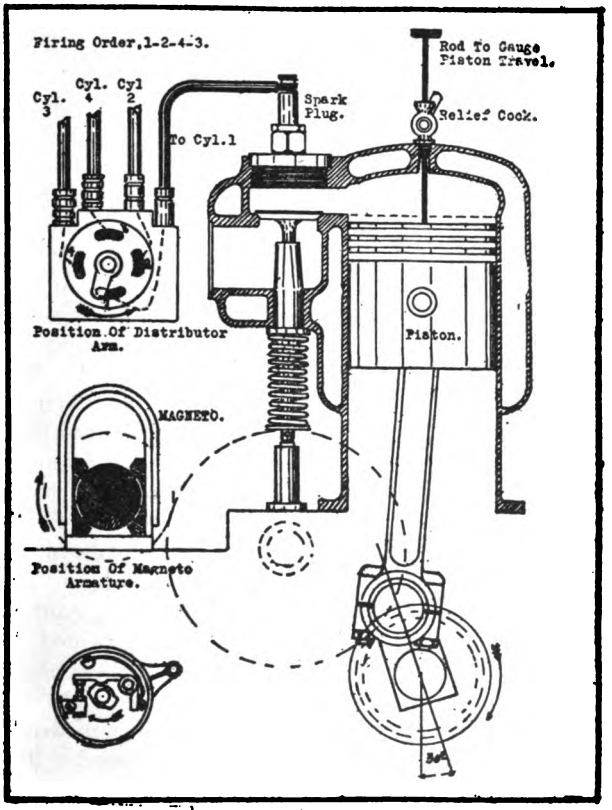


FIG. 12—MAGNETO TIMING DIAGRAM

The movement of this will correspond to the travel of the piston. With the spark lever fully advanced and the contact breaker case at maximum advance position, the magneto armature is revolved by hand till the contact points are just about to separate, at which point the driving gear of the armature should be meshed with that of the camshaft. The distributor is driven by gearing integral with the magneto and is assumedly properly timed at the factory. If the engine is a multiple-cylinder type the distributor cover is removed and the segment with which the distributor arm is in contact is wired to the plug in the cylinder about to fire. The remaining contacts are then wired to the cylinders in the order that they fire, which order varies in different machines. At this time the armature driving gear is firmly attached to the shaft by pins, key or is forced on a taper with a nut. The firing order of the system shown is 1, 2, 4, 3, and the remaining cylinders are coupled in the order named. The direction of distributer brush rotation, if driven by gears, is opposite to that of the magneto armature, though in some forms it is driven directly from an extension of the armature shaft and obviously turns at the same speed and in the same direction. If one cylinder is properly timed, and the others are coupled in proper firing order, they will be timed also. The positions of the armature, distributer brush, contact breaker cam and piston, are easily ascertained by inspection of the drawing. The dotted line above the piston indicates the end of the stroke and the firing position under normal conditions; for instance, when the engine is running at moderate speed. The contact breaker box may be rocked back and forth to vary the point of breaking contact, and conse-

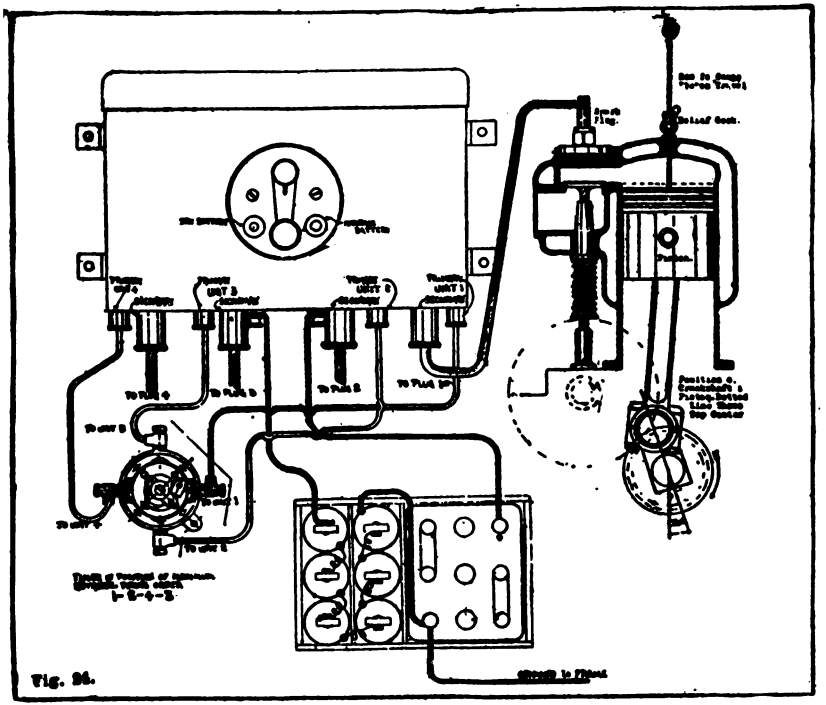


Fig. 24.

Timing High-Tension Ignition System—Arrangement of Parts in Cylinder 1 and Timer, with Spark Lever in Maximum Advance Position; Wiring to Other Cylinders as All 4-Cylinder, Firing 1-2-4-3.

quently the time spark will take place in the cylinder. If the timing is correct the spark will occur in the cylinder approximately at center when the contact breaker case is at central position, and a little after the piston has left top center when the spark lever is fully retarded.

TIMING THE SPARK-BATTERY IGNITION.

Timing the spark is easily accomplished after the parts are installed and properly coupled by varying the position of the rotating brush in the timing device, having it make contact with the insulated segment at the time that the piston in the cylinder to be fired is at ignition point. This can be done in several ways, one of these being shown at Fig. 24. The spark advance lever is coupled to the timer case and is set in the position of maximum advance. The piston is brought up on its compression stroke until about one-half inch (on an average) from the top. The revolving brush or cam is then brought round on the shaft till it just makes contact with the stationary electrode and is then securely fastened to its shaft. The lever is then moved back to about the middle position on the quadrant, and the piston moved up to the end of the compression stroke. If the brush again makes contact, the timing is correct. Another method is the reverse of the process described, the spark advance lever being placed in retard or late position, and the piston brought over the top compression point and about one-quarter inch down its stroke. The revolving brush is then set to make contact with the stationary electrode. Then again one may place the spark lever in center

position on the quadrant, bring the piston exactly on the top compression stroke and set the revolving cam to just make contact. Any of these methods are satisfactory.

If the engine is of the multiple form, one can watch the inlet valves and note the order of their operation; this will give the firing order. A common method of igniting four-cylinder engines is 1, 2, 4, 3. In this event cylinder 1 is timed first, then the wire leading to the primary terminal of the unit of the coil whose secondary lead is coupled to cylinder 2 is wired to the next stationary contact on the timer case in the direction of cam rotation. The primary wire from the unit coupled to No. 4 spark plug is connected to the next segment, while that of the unit No. 3 is attached to the last stationary contact on the timer case. Advancing the spark, or giving it a greater lead, is accomplished by so moving the stationary contact that it may close the circuit earlier, which can be done by moving the timer case in a direction opposite to that of the movement of the revolving contact member. Moving the timer case away from the revolving member will retard the spark. To increase the speed of the engine the commutator is advanced from the central position, which also advances the time of contact, so that the spark will take place earlier in the cylinder and give it sufficient time to fire the charge under the new conditions. There should be no lost motion in the rod or lever controlling the timer case movements, and care should be taken that the insulated contact segments are away from metal parts at all positions of the timer case.

MULTIPLE UNIT COILS.

When coils are to be used for firing multiple cylinder motors, there are two general systems in vogue, the simplest being a single unit coil and a distributing device to direct the secondary current to the plugs. The more common system uses a distinct unit for each cylinder to be fired and a com-

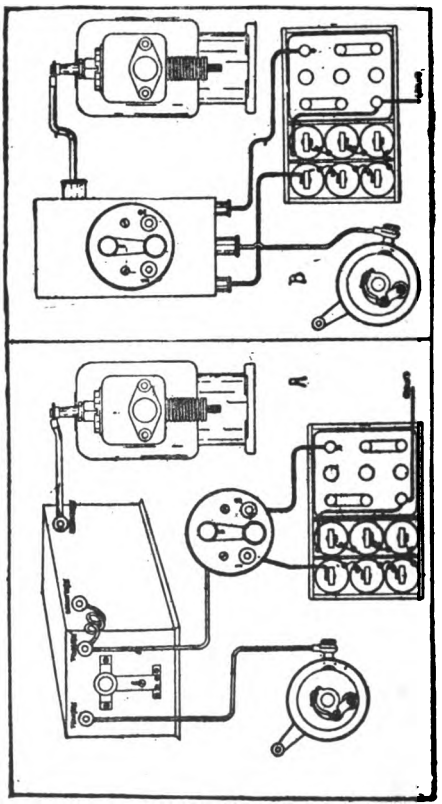


FIG. 13—WIRING OF SINGLE CYLINDER SYSTEMS
A Is a Rear-Terminal Box Coil With Separate Switch, B a Dash Type Coil With Switch Attached, Affording Greater Simplicity of Wiring.

mutator or timer which distributes the primary current to each coil at the right time for ignition in the cylinder with which it is connected. The internal wiring of a multiple unit coil is very much the same as though the same number of box coils were joined together by external wiring. At Fig. 14 is shown a two-unit coil and the internal wiring at A and B. A four-unit coil and internal wiring is shown at C and D. As will be evident, but one primary and one secondary lead are necessary for each unit when the switch is attached. If the switch were a separate appliance there would be need of an additional terminal, to which would be coupled the connection, where both primary and secondary coils are joined together, of all the units. A coil for double-cylinder ignition will have six terminals if an attached switch for using two sets of batteries is attached, and five terminals if the switch is a separate appliance, such as on box type marine coils. A four-unit coil will have 10 terminals if an attached switch is provided, and nine terminals if without this device. The internal wiring scheme of other forms of multiple unit coils is the same as those shown, save that more units would be coupled in exactly the same manner in a six-cylinder coil, and there would be 14 terminals instead of six or 10.

ONE CYLINDER WIRING.

To simplify wiring systems many coil manufacturers have placed the switch on the coil box, especially in dash type coils. This location of the switch makes for convenience of installation, as well as it being easily reached when it is desired to either make or interrupt the circuit. The diagrams presented at Fig. 13 are of a box type vibrator coil

with a separate switch. On the box type coil shown at A there are four terminals, two primary and two secondary. One primary and secondary are coupled and a wire is led to the central terminal of the switch. From the batteries, two sets being employed, wires are run to either side of the switch from terminal of the same polarity on either battery set. The

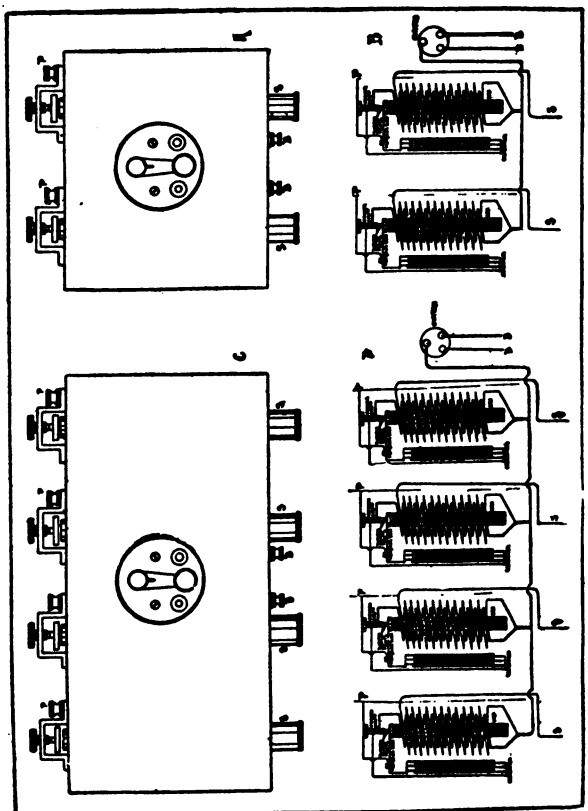


FIG. 14—INTERNAL WIRING OF MULTIPLE UNIT COILS

Upper Views Show Position of Terminals, the Lower Arrangement and Internal Connections of Components—P Indicates "Primary," Where Timer Leads are Attached; S "Secondary" or High-Tension Terminals, Coupled to Plugs; B B the Battery Terminals Leading to Switch Buttons.

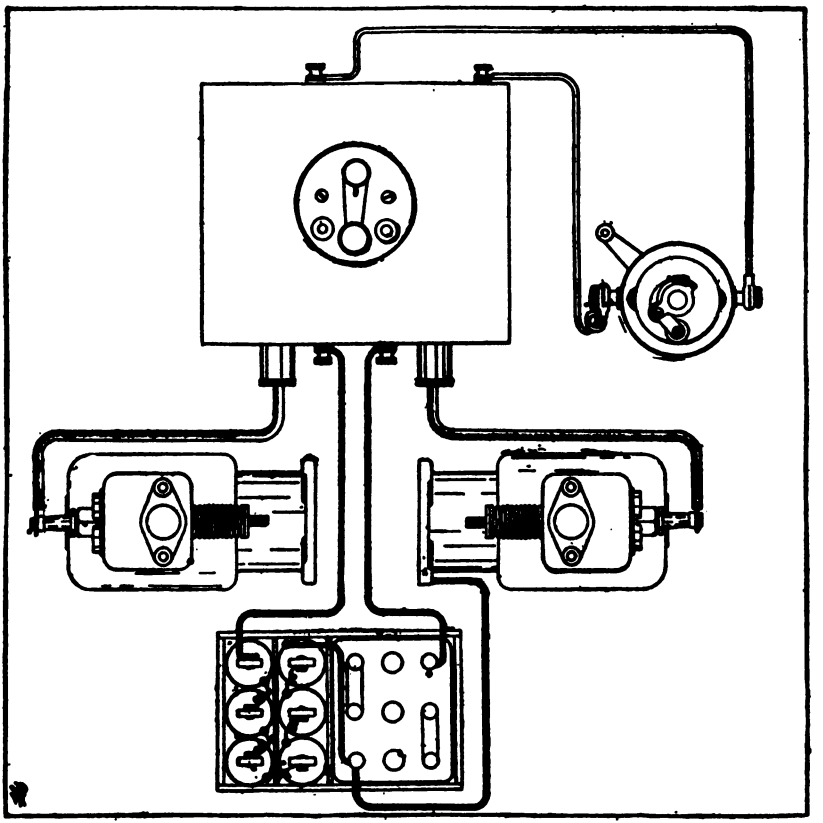


FIG. 26—IGNITION SYSTEM. TWO-CYLINDER OPPOSED MOTOR

remaining terminals, one on each battery set, are coupled and grounded. The remaining primary terminal on the coil box is attached to the insulated contact segment of the timer, while the remaining secondary terminal is coupled with the plug. As will be evident, the purpose of the switch is to bring either set of batteries into the circuit at will. When the switch arm is in contact with Button 1, the dry cell battery is used; when on Button 2 the storage battery is furnishing the current.

If we compare the diagram B with A, it will be seen that there is less external wiring, as the coil is of the dash type with attached switch, connection of the switch lever to the primary and secondary leads, joined together, being made inside the coil. This coil has four terminals to be coupled to the outer circuit, one secondary that is joined to the plug, one primary coupled to the insulated contact of the timer, and two batteries which are attached to the positive poles of the dry and storage cell sets.

WIRING DIAGRAMS OF MULTIPLE-CYLINDER COILS.

In wiring multiple-cylinder coils employed for four- or six-cylinder engines, the connections are very simple, being merely a repetition of those employed for the simpler single- and double-cylinder forms. Any coil which is composed of a number of units will have but one primary and one secondary terminal for each component, and if without an attached switch, an extra one will be provided for attaching the wire from the central button or lever of the separate switch, which in turn can be utilized to place either set of batteries in circuit with the coil. Thus a four-cylinder coil has either 9 or 10 ter-

minals, and of these 4 are attached directly to the timer contacts, four to the plugs and the remaining one or two, as the case may be, to the battery, as shown in illustrations.

A six-cylinder coil will have six units, and either 13 or 14 terminals. As will be evident from diagram Fig. 30, there need be no difficulty presented in

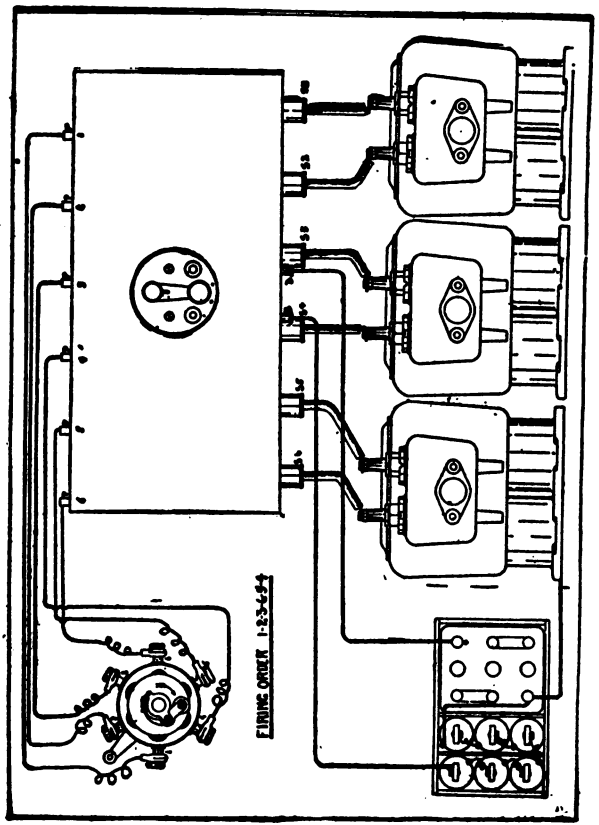


FIG. 30—6-CYLINDER MULTIPLE UNIT COIL WIRING.

making proper connections. A 14-terminal type with attached switch is shown in this sketch. Of these, six are primary terminals, six are of secondary or plug wires, and the remaining two are for the wires which come from the battery sets. The plug wires are invariably connected in rotation—that is, wire from unit one to plug in cylinder one, from unit two to plug two, etc. It is necessary to vary the firing order because it is never as regular as this, and according to the manner in which the cylinders operate, so the wires must be coupled to the timer contacts. For example, if the explosions occurred as 1, 2, 3, 6, 5, 4, the primary of units 1, 2 and 3 would be attached one after the other around the periphery of the timer in the direction of the rotation of the center contact member or cam while the primary terminal of unit 6 would be coupled to the next one, and those of units 5 and 4 in that order. One can always determine the direction the cam revolves by turning the engine over with the starting handle, and the order of cylinder firing is easily ascertained by watching the order of inlet or exhaust valve opening.

THE SECONDARY DISTRIBUTER.

At Fig. 17 is shown typical forms of this device, which will serve to make the construction clear. It will be seen that a secondary distributer consists of a primary timer to which is attached the secondary distributer, the contacts of each being arranged so that contact is made at the same time, this to insure absolute accuracy in distribution. It is usual practice to make contact in the primary circuit as many times as there are cylinders to be fired, and to attain this end the terminals of the contacts are usually

bridged by a strip of metal connected to the circuit, or a single contact is provided, there being as many points on the revolving cam member as there are cylinders to be fired. Obviously there will be as many contacts and interruptions in the primary circuit as there are points on the cam or terminals connected together. At each contact or completion

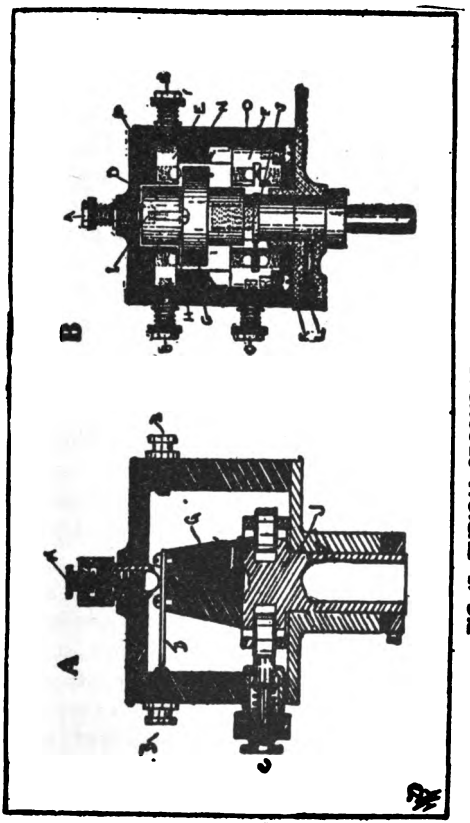


FIG. 17—TYPICAL SECONDARY DISTRIBUTERS

Parts Designated as Follows: A, High-Tension Terminal; B, Secondary Collectors Leading to Plugs C, Primary Current Interrupter; D, Secondary Distributing Brush; G, Insulating Block; J, Revolving Cam Member.

of the circuit the vibrator will operate and a secondary current will be induced in the coil. When the engine is running at high speed there is practically no stop to the vibrator, because its inertia tends to keep it in motion. This increases the motor speed, as there is no time lost after the primary coil is energized in setting the vibrator in motion and lag is eliminated. The secondary current is led to the central terminal, which contacts with the distributing brush, which in turn sends the current to the cylinder to be fired.

The form shown at A consists of a composition casing, having one primary contact at the lower end and as many secondary contacts at the upper end as there are cylinders to be fired. The central revolving member is supplemented by a fibre block, which carries the distributing segment at the top. For each cylinder to be fired a roller is provided in the revolving contact member. The cover, which carries the main high tension lead, is easily removable for cleaning, and plenty of air space exists between the primary and secondary portions of the distributer, this being an effectual insulator of the high-tension current. The secondary terminal screws are not in actual contact with the distributing arm, being separated by an air gap of several thousandths of an inch.

There is a certain theoretical advantage attached to the use of a spark gap in the secondary circuit which warrants its use. The objection sometimes advanced is that the current must be stronger to jump two gaps than is necessary to overcome the resistance of one, and that more current must be made to flow through the primary coil, the amount of which would be materially reduced if the gap

between the secondary distribution points was eliminated. The appliance shown at B makes a positive electrical connection at the secondary distribution points as well as at the primary contacts. This distributer has two cams and two sets of ball contacts, one being for the timer, the other for the distributer, the only difference being that in the latter there is but one ball to each contact and that the

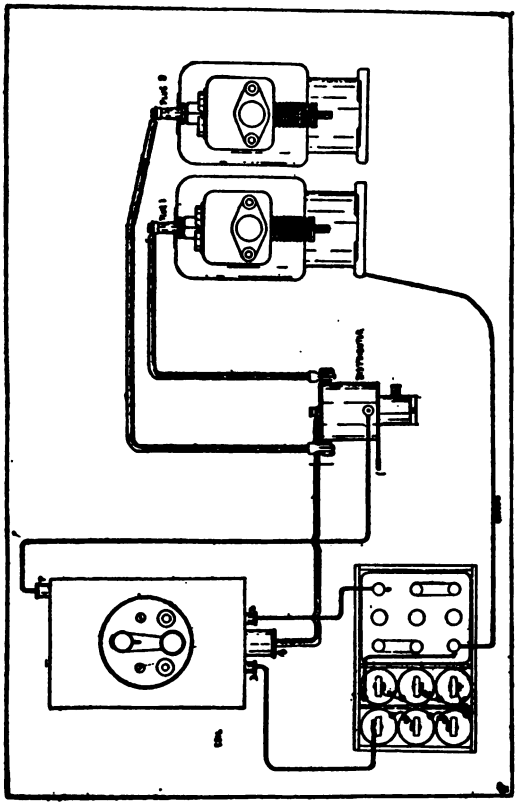


FIG. 31—2-CYLINDER DISTRIBUTER SYSTEM

cam is well insulated from the shaft. The connection is made and the circuit closed for each cylinder as the cam passes between the balls. As the circuit is closed in the distributer before it is closed in the timer and broken first in the commutator, there is no possibility of the current following the cam when the latter leaves the contacts in the distributer, nor of the current jumping and firing the charge prematurely of firing the wrong cylinder. The primary contacts are all wired together by means of a metal band, a single joint cam being employed.

DISTRIBUTER SYSTEM.

The advantages offered by the use of a properly constructed secondary distributer and single coil outfit is the simplicity of wiring. At Figs. 31, 32, 33 it will be seen that but one single unit coil is needed, and one primary wire leads from the coil to the single primary terminal of the distributer. From the coil the secondary lead is attached to the high tension terminal on the distributer, which has direct bearing on the distributing segment, and the terminals which are spaced around the periphery are attached to the plugs in the order of firing.

The method of timing is exactly the same as that employed with the primary timer, except that the revolving high tension distributing brush is used as a gauge or indication; this should register with the terminal leading to the plug in the cylinder that fires when the piston is at the proper point, as shown at Fig. 24. Then, according to the firing order, the other terminals are coupled to the plugs. The diagrams are so clear that further explanation seems unnecessary.

LOW-TENSION IGNITION.

The low-tension system is used to some extent by automobile designers, though the high-tension systems are most popular. We have learned that to obtain a spark in the cylinder that there must be a make and break in the circuit, and it is upon the method of producing this interruption that the successful operation of the low-tension system depends.

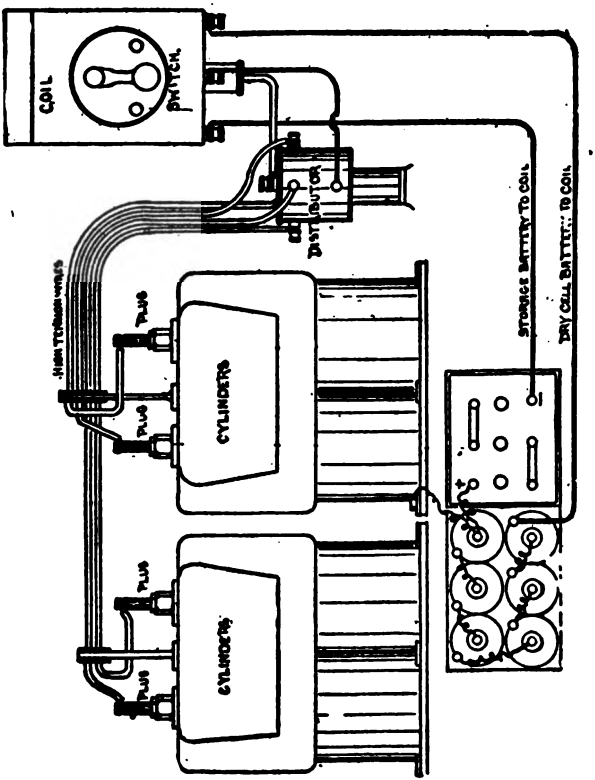


FIG. 32—4-CYLINDER DISTRIBUTER IGNITION GROUP.

The break must be positive, and, to be capable of practical application to automobile engines, the operating mechanism employed must be operative at the maximum number of revolutions the engine may develop. It will be evident much depends upon the design of the igniter plate.

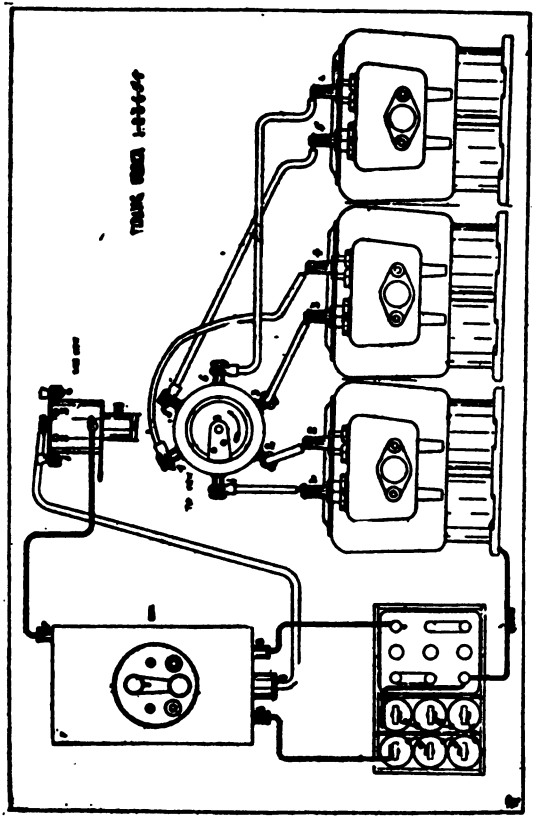


FIG. 33—4-CYLINDER DISTRIBUTER WIRING DIAGRAM

The coil used with the low-tension system is a very simple form, being a primary winding of comparatively coarse wire, around a core of soft iron wire. The current from batteries is intensified in this coil by the phenomena known as self-induction, and one coil is sufficient for any number of cylinders. When contact is made a current flows through the coil, this

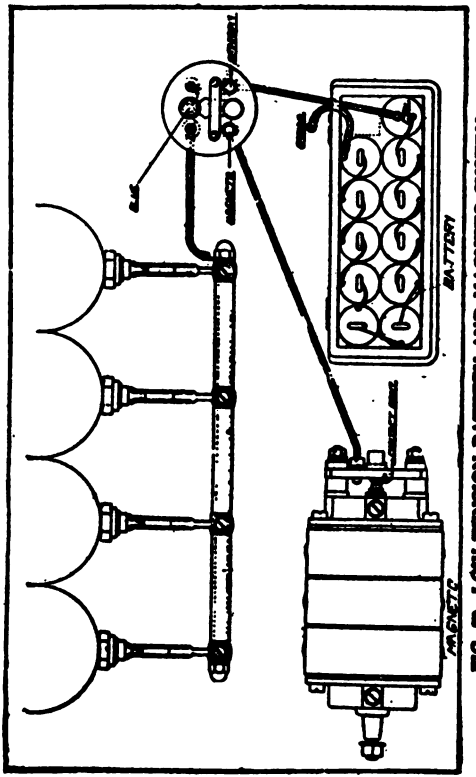


FIG. 28—LOW-TENSION BATTERY AND MAGNETO SYSTEM
Simplicity of Wiring Shown—By Two-Way Switch Either Battery or Magneto Current May Be Led to the Bus Bar.

producing a brilliant spark when the contacts of the sparking plate separate. As will be evident from diagram (Fig. 20) the wiring of such a system is very simple. A magneto is usually employed as a regular source of energy, as the demands are too severe to be properly taken care of by chemical generators, these being usually carried for emergency service. In the case of single-cylinder slow-speed motors, such as used for propulsion of craft, batteries may be used with success. From the magneto terminal a wire runs directly to a bus bar or common conductor which is insulated from the engine and attached to the insulated contact on each igniter plate by means of short wires or strips of metal. The other magneto wire is grounded. The batteries are coupled in series connection, one pole of the set being coupled to the coil, the other coil terminal being led to the bus bar through the switch lever when desired. As is evident, the coil is in series with the batteries, as are the igniter plates, a return being provided through the ground to the batteries.

A TYPICAL IGNITER PLATE. LOW-TENSION IGNITION.

There are many forms of igniters in common use, these being divided into two distinct types, those using a wipe contact, the others that employ a touch contact. The latter are practically the only form used at present, and most engines using the low-tension system are equipped with a make and break igniter. A typical form, as used on the Locomobile car, may be considered representative of standard practice, and cuts presented herewith show the construction and application of this appliance very

clearly. Referring to Fig. 21, it will be seen that the igniter consists of a triangular drop forged plate, having a cone fit in the cylinder, and being secured by three bolts to the corner of the combustion chamber over the inlet valve, where it is directly in line of the cool incoming gas. It carries an anvil (or fixed electrode) and a hammer (or moving electrode). The anvil is an insulated steel rod passing through the plate into the combustion chamber; the hammer is L-shaped, that part inside

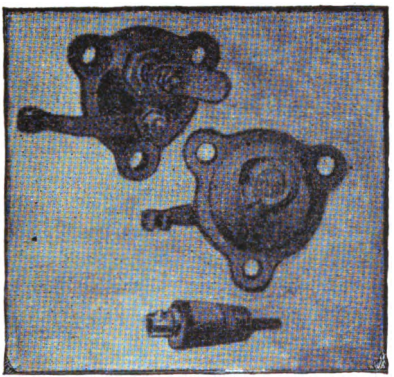


FIG. 21—LOW TENSION IGNITER

the cylinder alternately striking and separating from the anvil, and where the hammer passes through the igniter plate there is a cone bearing which prevents any escape of gas.

The part of the hammer outside of the cylinder is made in the form of a short lever, ending in a jaw-shaped opening connected with the top of the lifter rod, which is given vertical motion by the igniter cam on the admission valve camshaft. When the lifter rod moves upward the part of the hammer

inside of the cylinder comes into contact with the anvil, and when the revolving igniter cam reaches the proper point the lifter rod falls, this action being accelerated by a spring at the bottom of the lifter rod, causing a very quick, sharp separation of the

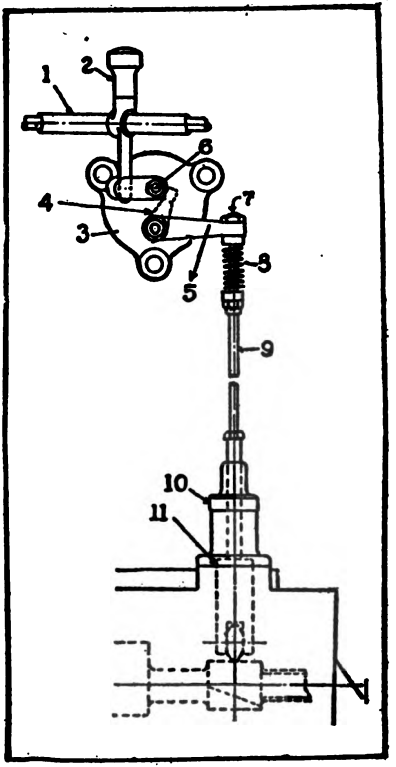


FIG. 22—IGNITER ACTUATION

1—Bus Bar. 2—Knife Switch. 3—Igniter Plate. 4—Hammer. 5—Hammer Lever. 6—Igniter Anvil Plug. 7—Ball Nut. 8—Igniter Lifter Rod Spring. 9—Igniter Lifter Rod. 10—Igniter Lifter Guide. 11—Igniter Lifter.

contact surfaces and producing a spark at the right time for igniting the gas. The igniter lifters are furnished with springs at the top, a simple manner of insuring good contact between the hammer or movable electrode, and the anvil or fixed electrode. One of the difficulties with the make and break system as ordinarily employed is the burning or wearing down of the contact surfaces. This can be largely reduced by the use of iridium or platino-iridium points, a globule of this metal being attached to the anvil and the side of the hammer, which makes contact. This metal is very hard and has good resistance to heat, and for this reason there can be no great wear or deterioration by burning through the heat of the spark, as would be the case with a softer metal. Such contacts are usually secured by riveting, as brazing is not always satisfactory when exposed to heat. The anvil is conveniently made in the form of a readily detachable unit which can be withdrawn, in connection with the insulating bushing, and cleaned. Mica and lava are the materials commonly used, porcelain being unsuitable, because the bushing is in direct contact with the metal and tightly clamped in place, a taper joint being used in most cases to retain the compression and explosion pressures. This method of installation offers no opportunity for expansion, and porcelain would crack, because of its lack of flexibility. A typical igniter plate and operating mechanism is shown at Fig. 22.

HOW TO TIME LOW-TENSION IGNITION SYSTEMS.

The method of varying the time of ignition is simply accomplished. The entire admission camshaft upon which the ignition cams are placed as well, can

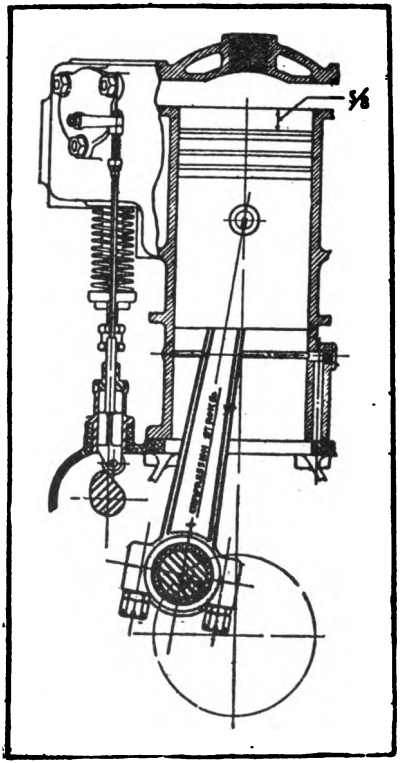


FIG. 23—TIMING IGNITION
With Spark Lever Fully Advanced Contacts of Igniter Plate Should Separate When Piston Reaches Position Shown.

be moved lengthwise on the bearings. When the spark advance lever on the steering post is pushed forward the camshaft is moved forward and the spiral ignition cams assume a different position and cause the break to take place earlier. This method is very simple and of practical utility. If it is necessary to retime the spark, owing to removal of the timing shafts, it can be easily done, as illustrated at Fig. 23, which, while applying specifically to the Locomobile motor, can be modified to meet the different conditions in any other engine. The flywheel of a multiple-cylinder engine is usually marked with the proper points for ignition and valve opening and closing. To time a single-cylinder engine is a simple matter, and even if the flywheel of the multiple-cylinder form is not marked, timing each cylinder individually is possible. If the points have been renewed one need not go over the entire timing, it being merely necessary to get the piston at the proper firing point, and adjust the operating rod so that the points of the igniter plate are just about to separate. In the Locomobile motor this point is just five-eighths inch before the completion of the compression stroke with the spark lever fully advanced.

To retime the spark proceed as follows: Remove the floor-board. Open pet cocks in the top of the cylinders. Advance spark fully and apply the emergency brake to release clutch. Turn the starting crank so that the mark on the flywheel reading "Advance spark 1 and 4" is just opposite the trammel or pointer placed exactly on the engine center line and the engine base. Cylinder 4 should be on the compression stroke. Loosen check nut at the bottom of the tappet rod of No. 4 cylinder (the

one immediately in front of the dash), and screw down on the tappet rod slowly and carefully until the ball nut (Fig. 21) on the top of the rod just settles into the socket on the end of the lever arm of the igniters; tighten the locknut and the igniter should be properly timed—the break occurring five-eighths inch below top center, with the spark fully advanced. Note that the hammer lever is at right angles to the tappet rod when the hammer and anvil are in contact. In order to time No. 1 cylinder it will be necessary to give the motor one complete revolution, bringing the same mark back to the pointer again. In all cases the motor should be revolved in the direction of rotation, which can best be done by turning it over with the starting handle. It is necessary to turn the motor one complete revolution, as cylinder 1 is exhausting while 4 is compressing, the full revolution being required to bring the former on the compression stroke. Next turn the engine until the reading, "Advance spark for 2 and 3," comes under the pointer, setting the ignition for No. 2 cylinder. Turn engine a complete revolution until the same mark is under the pointer again, and then time No. 3 cylinder. When a cylinder is on the compression stroke, both valves are closed, whereas on the other upstroke the exhaust valve is open.

In other engines, if the flywheel is not marked, a rod may be inserted through the pet cock and the travel of the piston gauged, as shown at Fig. 24, which shows the method of timing a high-tension system. The space shown will vary with the stroke of the motor to be timed, the five-eighths inch before completion of compression stroke applying to a motor with a four to four and one-half inch stroke.

If the stroke is less the space should be less, and it should be increased if the stroke is greater. A good indication is to mark off the flywheel in degrees—that is, divide the circumference by 360, making a number of marks to correspond to 5, 10, 15, 20, 25, 30 degrees at each side of the top and bottom center marks. With the spark control lever in full advanced position, the points should break about 30 degrees ahead of the point on the flywheel denoting full compression position. If the spark is fixed, that is, no advance being provided, as is often the case in marine engines, the break should occur when the piston reaches top of compression stroke.

CAUSE OF VALVE GEAR NOISE.

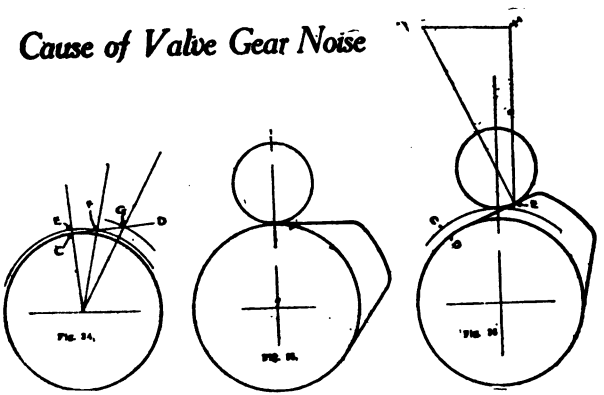
Many an engine, especially an old engine, is unnecessarily noisy because of superfluous clearance between the valve lifters and the valves, and a great part of the noise may be eliminated simply by the expenditure of a little time and care in reducing this clearance to the minimum. Every valve cam, no matter what its shape otherwise may be, is tangential, at the first and last portion of the valve's movement. (The sooner the valve takes hold of the cam on the lift, and the later it lets go on the descent the slower will be the movement of the valve at these instances, and the less will be the shock both of the lifter on striking the valve stem and of the valve head on meeting its seat.) Fig. 34 shows this clearly. The tangent line C D starts at C, and during the arc E F the rise of the cam amounts to only a minute distance, C E. During the following equal angle, however, the lift is three times as great.

It is a common idea that the valve lifters should in all cases be adjusted to open and close the valves

at certain crank angles, which usually are arbitrarily assumed, and with few exceptions will be found to be nothing but guesswork. As a matter of fact, it is seldom indeed that the cams of any engine, particularly any engine over two or more years old, holds the valves open too long if the whole effective angle is utilized.

It is quite true that the cams may not be exactly alike, and some hold their valves open longer than others in the cylinder. The fact is not suffi-

Cause of Valve Gear Noise



cient to justify what amounts to throttling certain cylinders in order to equalize them down to the less efficient ones. This applies to both the inlet and the exhaust valves. It is, however, possible that advancing or retarding the valves one tooth on the cam gear may be found anvantageous.

In ordinary engines the exhaust valves should not open earlier than 45 degrees crank angle before the bottom center, and they should not close before the top center, nor more than 20 degrees after top

center. Experience has shown that 40 degrees above bottom center and 15 degrees past the top center is about right. The exact figures, however, will depend on the form of the exhaust manifold and the action of the muffler, and no arbitrary rules can be laid down.

If the valves are on opposite sides of the cylinders the openings of the exhaust and inlet valves may overlap as much as 10 degrees on the crank without detriment, and a 5-degree overlap may be allowed even when the valves are close together.

The objection to an excessive clearance is not simply the vertical hammering, but the sidewise pressure imposed on the valve lifters by the cams, particularly at the instant of opening the exhaust valves. If it were possible to operate the valves with no clearance whatever, and if there were no lost motion, and if the whole mechanism were ideally rigid, the line of pressure of the cam at the instant could be said to be vertical, and there would be no side thrust till the valve was off its seat and the pressure of the gases on the valve was partly equalized.

As the matter actually stands, however, there is a side thrust which is considerably increased by unnecessary clearance, as comparison of Figs. 35 and 36 clearly shows. In Fig. 35 there is no clearance, and the tangent to the line of contact is horizontal.

In Fig. 36 there is a clearance, C D. The thrust acts at right to the tangent along the line E F, and if E H represents by its length the force required to overcome the pressure on the valve and the force of the spring, there is a horizontal thrust equal to F H.

It goes without saying that valve-lifters thus adjusted will wear loose in the guides faster than they should. As the gas pressure on the valve head may amount to 30 or 40 pounds per inch before the valve is open, there is an evident tendency to wear a hollow in the cam at the precise point where it starts the exhaust valve from its seat. Evidently, moreover, the smaller the clearance, the greater will be the leverage of the cam and the smaller will be its wearing tendency.

The precise amount of minimum clearance is hard to state arbitrarily. The thickness of a business card, or about 10/1000 of an inch is ample allowance for the expansion of valve stems for the average length. Frequently, however, this allowance must be increased, owing to irregularity of the cam profile or irregular wear of the contact ends of the valve stems and lifters or of the roller.

The cam must, of course, clear the valve throughout its entire idle arc, and it is well not to take the chance of a half turn of the valve, causing it to touch the lifter, owing to the end of the stem not being square. If the roller and pin of the lifter show wear it is safest to renew them, as a small irregularity here has a marked effect on the performance of the motor.

CARE OF THE BATTERIES.

Keep the terminals, top and case clean; never turn a storage battery on its side, as *the acid* will be spilled. Do not knock the box against any hard objects.

After you have made the connections to your sparking circuit, coat the terminals with grease;

this will prevent the wires corroding and will keep the nuts from sticking.

Do not wait until your engine begins to miss fire, but have the battery recharged every month.

Have the battery charged once a month whether weak or not.

Storage batteries should be held tightly in their box. Rubber sheeting is good for packing the batteries and deadens vibration to a large extent.

PRACTICAL HINTS ON THE CARE OF AUTOMOBILE TIRES.

If it were possible to secure adequate statistics of automobile accidents, grave, fatal and otherwise, we believe it would be found that fully 60 per cent. of them have occurred on curves and corners of roads and streets. The risks taken by the average driver at such points on even the open country road, if not exactly appalling, certainly are astonishing. The wonder is that accidents are not more numerous, according to *Motor World.* For even at the legal rate of 20 to 25 miles an hour a car need be even so slightly "out of hand" to cause it to fly off at a tangent on even a comparatively gentle curve. It follows that the greater the speed the greater the danger. There is small doubt that the lack of proper caution on curves has been the cause of many apparently inexplicable accidents that have had tragic consequences, and which have been attributed to other reasons, not infrequently to blow-outs or tires pulling from their rims. It is a splendid tribute to their manufacturers that tires stand up so remarkably well when the punishing work to which they are put is considered, and the terrific strains to which they are subject in the course of a day's

or month's use. Of such strains none are severer or more destructive than the incautious or heedless manner in which cars are whirled around corners and curves, and by heedless is meant failure to reduce speed.

The condition of the road surface wherever more than the gentlest of curves prevails usually serves as evidence, not only of the dangers that lurk there, but of the strains that are imposed on tires and the destructive effects on the road itself; of the practice of changing direction without material reduction of speed. It is on the curves that the roads always are badly worn and torn up, the stone of macadam paving being literally rooted out. It is a condition which suggests a lesson that road builders have not yet taken sufficiently to heart, for apparently they have made no effort to find or to use a more enduring form of construction or material at the points where it long has been plain it is most required, and where it would considerably reduce the cost of maintenance and add to the creature comfort of all who use the roads.

Other ways of reducing the tire expense is to see if the car is equipped with proper size tires for the weight and work required. It should be kept in mind that not only the weight of the car should be considered, but also the weight of the passengers and the luggage which the car may be called on to carry. Always keep the tires properly inflated; it will lengthen a tire's life considerably. It is just as easy to overinflate as to not pump in enough air.

Never put the brakes on hard enough to lock the wheels unless absolutely necessary, as it will cause the tires to slide and the surface of the road will cut them.

The road is not always to blame for skidding, although that appears to be the general impression. Experienced chauffeurs have frequently found that the sudden application of the brakes and the resulting unequal pressure on the brake bands will cause the rear end of the *car to slew* around. The best way to cross newly laid stones is to run the car declutched over the section at as low a speed as possible—that is, the driver should take the patch declutched sufficiently fast to land just clear of the stones on the other side. If the stretch is a long one it is considered best to run on low speed and as slowly as possible, thus greatly reducing the driving impact and saving the tires to the utmost degree.

There is a way of locating a small puncture in an inner tube without putting it in water. Let the air out of the tube entirely, and before putting the valve in again blow several mouthfuls of smoke into the tube. Replace the valve and pump the tube up to the right pressure, and you will see the smoke issue from any small leaks that may be in the tube.

Don't forget it is necessary that a tire should be fitted correctly to the rim. If this is not done blowouts will be frequent.

Inner tubes are sometimes caused to leak due to relaxation of the nut which clamps the stem to the tube. When this is slackened the pressure of the air contents of the envelope may be sufficient to hold the outer wall against the seat on the under side of the washer, thus preventing any escape of air under ordinary circumstances, but not strongly enough to hold when the stem is bent or pulled out of line. To test a tube which shows up good in all other respects, the only safe way is to twist the stem back and forth under water sufficiently to

pull the rubber slightly where it lies against the stem.

As a general rule the rear tires should show a pressure of 80 pounds and the front ones 70.

Heat, oil and age are three of the deadly enemies of the tire.

Tires which are out of service during the winter months should be removed from the wheels. This done, a close examination of the cases should be made, locating any cuts or abrasions that expose the fabric. These should be repaired at once. Neglect in this will cause deterioration of the fabric and soon result in the complete destruction of the casing. Before storing the cases it is advisable to wash the outside of them with a little gasoline. This will remove any traces of oil, which, if left on the tire, will have a tendency to soften and destroy the rubber. This done, it is best to wrap the cases in any light muslin or burlap and place them in a dark room out of the direct rays of the sun (a dark room is, of course, preferable). A temperature ranging from 30 to 40 degrees Fahrenheit is best to prevent oxidation. Tubes should be laid flat on a shelf in a dark cupboard, care being taken not to have any weight rest on them. The same temperature mentioned for the cases will apply to tubes as well.

The rims, if rusted, should be thoroughly cleaned and sandpapered, then painted with liquid graphite (common stove polish will answer). In case the tires are not removed the car should be jacked up so that no weight rests on the tires and part of the air released to relieve the strain on the casing, leaving only sufficient pressure to keep the tire tight and in shape. Unless some pressure is retained the

tube will have a tendency to fold and is liable to crack when again inflated.

Attention to the above will result in the prolonged life of your tire equipment.

The tire in itself is a great study, and by properly caring for it you will be amply repaid with added comfort and pleasure to your motor trips.

The upkeep of tires is considered the greatest running expense of a car. Did you ever consider that this could be greatly reduced if you would better post yourself on the *care of your tires?*

I would invite for the tire a little of the attention given the magneto, carburetor, etc.

Do not be too hasty in condemning a tire and its maker before ascertaining the real cause of its giving out.

Before pronouncing the tire defective be sure that it is at fault, and not cut, punctured, or its condition due to an accident received in service, for which you are responsible. It is an actual fact that the giving out of 75 per cent. of all tires, barring accidents, is due to neglect or misuse by the owner.

This misuse is not intentional on the part of the user, but in his attention to the rest of the outfit he has neglected to think much about the tires.

Air costs nothing; tires are expensive.

More tires give out from insufficient inflation than anything else. Remember that it is the air in the tube that carries the load and cushions the road.

Avoid sudden application of the brake.

If one side of a tire shows more wear than another, turn it around.

Running a tire flat, even a short distance, is sure to be costly.

Better run on the rim very slowly and carefully if imperatively necessary, and the distance is very short, than on a flat tire.

Keep grease and oil away from your tires and tubes always. They destroy rubber.

Keep rims in good order, straight and true. Rust is destructive. Paint preserves.

Speedy deflation demands instant attention.

Don't let weight rest on deflated tires even over night.

If your wheels are out of true, their want of parallelism will have a bad effect on the tire covers. The car travels at a twist and the wheels will be scraped instead of rolled over the ground—added friction, quicker wear-out to the tire.

Side skidding and rounding corners rapidly will cause rim cutting.

Make sure that tires are properly inflated before beginning trips.

Avoid running in street car tracks. It is very detrimental to the tires.

Do not drive in the ruts or bump the side of the tires against the curbing or pavements.

See that the size of the tires is in keeping with the weight of the machine and the load it is likely to carry.

Don't start your machine with a jump.

If one of your tires sustains a cut to the extent of exposing the fabric, an emergency band or patch should be applied at once.

I would recommend keeping an odometer record of the mileage of each tire. You will find that you are getting better mileage than you would otherwise imagine.

HOW TO REPAIR A SMALL HOLE OR CUT IN THE CASING.

Never allow a cut in the casing to go without immediate repair—moisture and dirt will surely enter in quick order and weaken the exposed fabric.

Look your tires over every once in a while, the oftener the better, and when you find a cut or gouge that extends to the fabric bear in mind that your tire is hurt to the quick—that is, the fabric is exposed to the disintegrating effects of moisture and dirt, which in short order will weaken the stoutest fabric, not only at the point of incision, but perhaps a foot or more away, as the dampness follows along the thread of the fabric like oil in a wick. This accounts for blow-outs at points on the tire where the service is intact. The remedy that serves all immediate needs is not necessarily a repair garage or a vulcanizing outfit. Just wash out and thoroughly dry the cut, then apply a good self-curing cement which is prepared expressly for this purpose. It can be purchased at any garage or automobile supply store. It is a self-drying, self-curing cement, easy to use and very effective, as it securely seats itself and seals the hole or cut against the entry of moisture or grit.

HOW TO WASH A CAR.

In washing an automobile, wet the car all over with clean water first, using a hose or sponge. After the car is thoroughly wet then wash with suds and immediately rinse with clean water. After this rub it dry with a piece of chamois. Be sure to wet the chamois first and then wring it out; if the chamois is not thoroughly wet it will scratch the varnished

surfaces. Never let the raw soap come in contact with the varnished surfaces, as it will spot and streak. The soap should be thoroughly dissolved in water and made into suds before using. A good plan is to first select a good, soft oil soap and put about one pound to each gallon of water; then let it dissolve, and use about one pint of this solution to one bucket of water. In this way there will be no danger of the raw soap coming in contact with the body. There are very few who understand the proper method of washing the varnished surfaces of a car. It should be borne in mind that the life of the varnish on a car entirely depends on the way it is washed. Of course, it must be understood to get the best results you should obtain a high-grade soft oil soap. There are several good oil soaps on the market today for washing automobiles, but few, indeed, who realize that economy is gained by using a high-quality soap.

TO RENEW DRY CELLS.

A very simple way to renew dry cells is to bore holes in the pitch at the top of the cell and moisten the interior with a solution of sal ammoniac or salt water, or you could use vinegar.

The following is also a dry battery renewer: Make a solution of calcium chloride, crystallized, 30 parts; calcium chloride, granulated, 30 parts; ammonia sulphate, 15 parts; zinc sulphate, 25 parts. Moisten the interior with it through holes bored in the pitch.

The writer does not recommend this method unless in cases of emergency. New cells would give better satisfaction.

A FEW THINGS WORTH KNOWING.

No one thing is responsible for more "automobile troubles" in a well designed and correctly constructed car than insufficient lubrication.

Nothing in a motor car is more essential to the safety of the motorist than a thoroughly efficient brake system.

Never run your engine to its maximum while the car is standing idle. It puts an unusual strain on the different parts.

Remember spark plugs that are in the cylinders are more likely to become fouled than those that are carried in the tool box. It is a good plan, when trouble comes, to take them out and clean them before taking the coil or magneto apart.

If you ever get stuck in the mud, and you have no chains or your chains will not get you out, procure a rope, fasten one end to a tree or fence, if there is no tree or fence, then drive a heavy stake in the road ahead, then fasten the other end of the rope around the axle or hub of one of the driving wheels. When the engine is started the rope will wind up on the wheel or axle and pull the car out.

Ignition trouble may be present, although the cylinders may not miss fire. The spark plugs may be dirty, allowing but a small spark to jump across the points.

When filling the gasoline tank it is desirable to place a piece of chamois in the funnel for the purpose of straining out all floating particles, as well as water, from the gasoline. Fine wire gauze may be used as a strainer, but it will not, of course, exclude water that may be mixed with the gasoline.

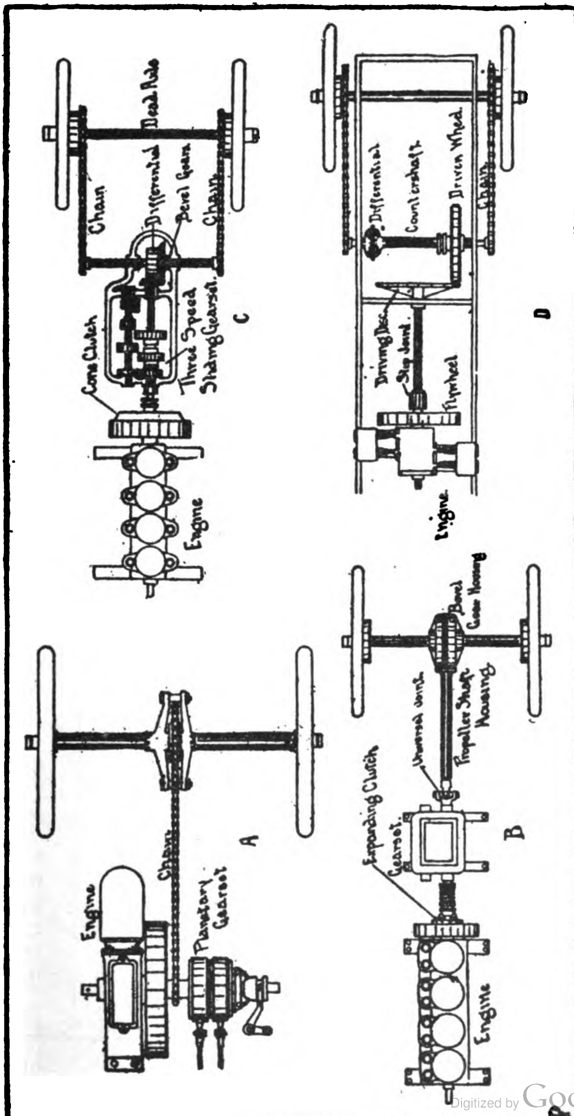
A gasoline fire may be extinguished with sand or earth; never use water. Ammonia will smother a gasoline fire if confined in a small space.

Never hunt a gasoline leak with an open light. The result of finding it may be disastrous.

Never pour gasoline out in a room where there is an open light, because the vapor of gasoline will be drawn to any nearby fire, candle, gaslight or lamp.

Never leave a gasoline vessel uncovered, because the currents of air draw out the vapor.

Never fill a can quite full, for gasoline expands much more than water when it becomes warm, and is likely to force open a seam in the can.



CONVENTIONAL FORMS OF MOTOR CAR DRIVING SYSTEMS.

A—Simplest Form, Direct Chain Drive. B—Transmission by Enclosed Shaft and Bevel Gear. C—Double Side Chain and Bevel Gearing in Combination. D—Side Chain with Friction Transmission.

HORSEPOWER FOR INTERNAL COMBUSTION MOTOR AUTOMOBILES.

CALCULATED FROM FORMULA:

$$\text{H. P.} = \frac{(\text{DIAM. IN INCHES})^2 \times \text{NUMBER OF CYLINDERS}}{2.5}$$

BORE		HORSE POWER			
Inches	Millimeters	1 Cylinder	2 Cylinders	4 Cylinders	6 Cylinders
2½	64	2.5	5.0	10.0	15.0
⅝	68	2.8	5.5	11.0	16.5
¾	70	3.0	6.0	12.1	18.1
⅞	73	3.3	6.6	13.2	19.8
3—	76	3.6	7.2	14.4	21.6
⅛	79	3.9	7.8	15.6	23.4
¼	83	4.2	8.4	16.9	25.3
⅜	85	4.6	9.1	18.2	27.3
3½	89	4.9	9.8	19.6	29.4
⅝	92	5.3	10.5	21.0	31.5
¾	95	5.6	11.2	22.5	33.7
⅞	99	6.0	12.0	24.0	36.0
4—	102	6.4	12.8	25.6	38.4
⅛	105	6.8	13.6	27.2	40.8
¼	108	7.2	14.4	28.9	43.3
⅜	111	7.7	15.3	30.6	45.9
4½	114	8.1	16.2	32.4	48.6
⅝	118	8.6	17.1	34.2	51.4
¾	121	9.0	18.0	36.1	54.2
⅞	124	9.5	19.0	38.0	57.0
5—	127	10.0	20.0	40.0	60.0
⅛	130	10.5	21.0	42.0	63.0
¼	133	11.0	22.0	44.1	66.1
⅜	137	11.6	23.1	46.2	69.3
5½	140	12.1	24.2	48.4	72.6
⅝	143	12.7	25.3	50.6	75.9
¾	146	13.2	26.4	52.9	79.3
⅞	149	13.8	27.6	55.2	82.8
6—	152	14.4	28.8	57.6	86.4

WEIGHT AND INFLATION SCHEDULE.

The table below gives the required inflation and the gross weights most tires are guaranteed to carry:

Size	Inflation	Rear Weight	Front Weight
28 x 2½	55 lbs.	225 lbs.	275 lbs.
30 x 2½	55 "	225 "	275 "
28 x 3	65 "	350 "	425 "
30 x 3	65 "	375 "	450 "
32 x 3	65 "	375 "	450 "
34 x 3	65 "	400 "	475 "
28 x 3½	70 "	425 "	500 "
30 x 3½	70 "	450 "	550 "
32 x 3½	70 "	500 "	600 "
34 x 3½	70 "	550 "	650 "
36 x 3½	70 "	600 "	700 "
30 x 4	75 "	625 "	750 "
32 x 4	75 "	650 "	800 "
34 x 4	75 "	700 "	875 "
36 x 4	75 "	750 "	900 "
38 x 4	75 "	800 "	950 "
40 x 4	75 "	850 "	1000 "
42 x 4	75 "	900 "	1050 "
32 x 4½	80 "	750 "	950 "
34 x 4½	80 "	900 "	1125 "
36 x 4½	80 "	975 "	1225 "
38 x 4½	80 "	1050 "	1300 "
40 x 4½	80 "	1125 "	1375 "
42 x 4½	80 "	1200 "	1450 "
35 x 5	85 "	1000 "	1250 "
37 x 5	85 "	1100 "	1350 "
39 x 5	85 "	1200 "	1450 "
41 x 5	85 "	1300 "	1500 "
38 x 5½	90 "	1200 "	1450 "
40 x 5½	90 "	1350 "	1600 "

HOW TO APPLY FOR A LICENSE.

The way to apply for an operator's license is to write to the State Board of License Commission for Operators (or its authorized agent) of the State in which you wish to drive an automobile, and ask for an operator's application blank, which will be promptly sent you. On receipt of same fill it out and mail it back with remittance to the License Board, who will inform you where and what day and date you should appear for an examination, all of which will require about a week.

COST FOR AN OPERATOR'S LICENSE.

The cost of an operator's license varies quite a good deal in the different States, and is subject to change. The price of the license, however, which ranges from $1 to $5, will be sent with the application blank.

CONCLUSION.

Of course, it is not necessary for the applicant for a chauffeur's license to familiarize himself with the entire contents of this book, but one should study pages from 4 to 18, that he may be able to answer the questions put to him. After studying pages 4 to 18 carefully, and to make himself sure he has mastered the instructions therein, go to some garage and look over the different cars and see if you have learned your lesson well enough to be able to tell what each lever, etc., is for. Of course, some cars are more complex than others, so if you are at fault with the first one try another. After which you can

hire an automobile with a driver for an hour of any auto school for a small sum, and go to the suburbs and try driving yourself, asking the driver that is with you any questions you may wish answered. Do this until you feel confident you have mastered your work.

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